U.S. CONGRESS.

JOINT COMMITTEE ON ATOMIC ENERGY

Hearings 1960
Volume 2

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AEC AUTHORIZING LEGISLATION FISCAL YEAR 1961

HEARINGS

BEFORE THE

SUBCOMMITTEE ON LEGISLATION

OF THE

JOINT COMMITTEE ON ATOMIC ENERGY

CONGRESS OF THE UNITED STATES

EIGHTY-SIXTH CONGRESS

SECOND SESSION

ON

AEC AUTHORIZING LEGISLATION
FISCAL YEAR 1961

MARCH 8, 10, 11, APRIL 5, 6, AND 7, 1960

Printed for the use of the Joint Committee on Atomic Energy

UNITED STATES
GOVERNMENT PRINTING OFFICE
53759 WASHINGTON : 1960

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AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1961

TUESDAY, MARCH 8, 1960

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON LEGISLATION,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m., in room 318, Old Senate Office Building, Hon. Chet Holifield (chairman of the subcommittee) presiding.

Present: Senators Anderson, Hickenlooper, Dworshak, and Aiken; Representatives Durham, Holifield, Price, Van Zandt, and Hosmer.

Also present: James T. Ramey, executive director; John T. Conway, assistant director; David R. Toll, staff counsel; Edward J. Bauser, technical adviser, and Bernard V. Dvoskin, GAO consultant.

Representative HOLIFIELD. The subcommittee will be in order.

The Subcommittee on Legislation of the Joint Committee on Atomic Energy is meeting today to commence hearings on S. 3084 and H.R. 10656, the AEC authorization bills for the fiscal year 1961 program. As announced previously, the subcommittee plans to hold these hearings in two portions:

First, from March 8 through 11, primarily to consider new construction projects in section 101 of the bill, and secondly, after receiving two design studies on April 1, from April 5 to 7 to consider the design studies, the cooperative power demonstration program in section 109 of the bills, and the other matters appropriate at that time.

I am glad to say that the Commission has made considerable progress in implementing projects initiated by the Joint Committee in the AEC authorization acts for fiscal year 1959 and 1960. At an appropriate place in these hearings we will include AEC's report of March 1, 1960, as to the status of these projects. (See p. 104.)

As Senator Anderson and I indicated during the 202 hearings on the state of the atomic industry, we have been particularly pleased that such projects as the Puerto Rico superheat project, the organic prototype, and the second round 50-megawatt boiling-water project, all of which the Joint Committee added for fiscal year 1960, are going forward.

On this coming Thursday and later from April 5 to 7, we expect to go into the AEC atomic power program, both the 10-year program and its 1961 edition, in somewhat greater detail than during the 202 hearings.

During that discussion we expect to consider possible additional projects, some of which are outlined in a staff letter to AEC, dated March 7, 1960. (See p. 300.)

At this point I would like, without objection, to place in the record our announcement of these hearings, Commissioner Floberg's letter of February 12, 1960, the AEC proposed bill for authorization of appropriations and the AEC analysis of the proposed bill, the tables AEC provides us each year, and to call your attention once again to table 8 at page 30, which compares AEC requests to the Budget Bureau and the items which reached Congress.

(The information referred to follows:)

No. 258—For immediate release, March 4, 1960

From the Office of the Joint Committee on Atomic Energy

Hearings on the AEC authorization bills for fiscal year 1961 (S. 3084 and H.R. 10656) are scheduled to begin next Tuesday, March 8, 1960, it was announced today by Congressman Chet Holifield, chairman of the Subcommittee on Legislation.

Congressman Holifield stated that hearings on the bills would be held in two parts, from March 8–10 and April 5–7, 1960. On March 8 and 10, public hearings will be held in Room P–63, the old Supreme Court chamber in the Capitol, and testimony will be received from Chairman John A. McCone, the other AEC Commissioners, AEC General Manager A. R. Luedecke, and AEC staff representatives on new construction projects proposed in section 101 of the bill. On Wednesday, March 9, 1960, the subcommittee hearings will be held in executive session in order to receive classified testimony, particularly in the atomic weapons and production programs.

On April 1, 1960, the Joint Committee is scheduled to receive reports from the AEC on two design studies authorized by section 113 of Public Law 86–50, the AEC Authorization Act for the current fiscal year 1960. Design studies are required on a prototype reactor for a nuclear tanker, and on a reactor for remote military installations.

Thereafter, on April 5–7, the subcommittee will hold additional public hearings on the bills, with emphasis on the design studies and on the cooperative atomic power program.

In announcing the hearings, Congressman Holifield stated as follows:

"The subcommittee will give careful consideration to each project proposed by the AEC. In addition, it is possible that the subcommittee will recommend to the full committee and the Congress, as it has in the past, some changes or additions if considered necessary or desirable to achieve national objectives in our atomic energy program."

U.S. ATOMIC ENERGY COMMISSION,
Washington, D.C., February 12, 1960.

HON. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: I have transmitted today to the Speaker of the House of Representatives and the President of the Senate proposed legislation in accordance with the provisions of section 261 of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2017), which would authorize appropriations for (1) acquisition or condemnation of any real property or any facility or for plant facility acquisition, construction, or expansion; (2) the continuation of the cooperative power reactor demonstration program; and (3) a cooperative research and development program with the Government of Canada.

Attached hereto are copies of the proposed bill and an unclassified analysis in support of the proposed provisions. A classified analysis, containing additional information, is being transmitted separately to your staff.

Sincerly yours,

JOHN F. FLOBERG,
Acting Chairman.

U.S. ATOMIC ENERGY COMMISSION

PROPOSED BILL FOR AUTHORIZATION OF APPROPRIATIONS, FISCAL YEAR 1961 PROGRAM

(See p. 310 for revisions proposed by AEC.)

DRAFT OF PROPOSED AUTHORIZATION BILL, FISCAL YEAR 1961

A BILL To authorize appropriations for the Atomic Energy Commission in accordance with section 261 of the Atomic Energy Act of 1954, as amended, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SEC. 101. PLANT OR FACILITY ACQUISITION OR CONSTRUCTION.—There is hereby authorized to be appropriated to the Atomic Energy Commission in accordance with the provisions of section 261a. (1) of the Atomic Energy Act of 1954, as amended, the sum of $171,25?,000 for acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion as follows:

(a) SPECIAL NUCLEAR MATERIALS.—

Project 61–a–1, modifications to production and supporting installations, $10,000,000.

Project 61–a–2, billet production plant, $1,800,000.

Project 61–a–3, heat treatment and inspection modifications, Fernald, Ohio, $2,500,000.

Project 61–a–4, development laboratory building, Oak Ridge, Tennessee, $766,000.

Project 61–a–5, plutonium reclamation plant, Hanford, Washington, $2,900,000.

Project 61–a–6, moderator purification improvements, Savannah River, South Carolina, $2,500,000.

(b) ATOMIC WEAPONS.—

Project 61–b–1, weapons production, development and test installations, $10,000,000.

Project 61–b–2, high velocity test track, Sandia Base, New Mexico, $2,100,000.

Project 61–b–3, special metals fabrication plant, $3,000,000.

(c) ATOMIC WEAPONS.—

Project 61–c–1, Tonopah Test Range, Tonopah, Nevada, $1,900,000.

Project 61–c–2, contaminated waste plant, Los Alamos, New Mexico, $2,000,000.

(d) REACTOR DEVELOPMENT.—

Project 61–d–1, additions and modifications to Chemical Engineering Building, Argonne National Laboratory, Illinois, $2,000,000.

Project 61–d–2, special purpose test installation addition, Santa Susana, California, $1,200,000.

Project 61–d–3, technical space for SPERT, National Reactor Testing Station, Idaho, $500,000.

Project 61–d–4, critical building, Brookhaven National Laboratory, New York, $600,000.

Project 61–d–5, fast reactor core test installation, Los Alamos Scientific Laboratory, New Mexico, $6,900,000.

Project 61–d–6, plutonium fuel service and development building, Los Alamos Scientific Laboratory, New Mexico, $600,000.

Project 61–d–7, test installation for project Rover, $20,000,000.

Project 61–d–8, test installation for project Pluto, $15,000,000.

Project 61–d–9, advanced test reactor, $24,000,000.

(e) REACTOR DEVELOPMENT.—

Project 61–e–1, additions and modifications, MTR-ETR area, National Reactor Testing Station, Idaho, $800,000.

Project 61–e–2, site utilities, Brookhaven National Laboratory, New York, $1,250,000.

Project 61–e–3, quarters for visiting scientists, Brookhaven National Laboratory, New York, $550,000.

(f) PHYSICAL RESEARCH.—

Project 61–f–1, bubble chamber house, Brookhaven National Laboratory, New York, $1,660,000.

Project 61–f–2, Princeton-Pennsylvania accelerator addition, Princeton, New Jersey, $1,350,000.

Project 61–f–3, accelerator and reactor additions and modifications, Brookhaven National Laboratory, New York, $1,285,000.

Project 61–f–4, high flux isotope reactor, Oak Ridge National Laboratory, Tennessee, $12,000,000.

Project 61–f–5, accelerator improvements, Lawrence Radiation Laboratory, California, $950,000.

Project 61–f–6, bevatron shielding, Lawrence Radiation Laboratory, California, $1,100,000.

(g) PHYSICAL RESEARCH.—

Project 61–g–1, metallurgy building extension, Brookhaven National Laboratory, New York, $655,000.

Project 61–g–2, addition to cyclotron building, Lawrence Radiation Laboratory, California, $500,000.

(h) BIOLOGY AND MEDICINE.—

Project 61–h–1, installations for support of biomedical research in atomic energy, $4,000,000.

(i) COMMUNITY.—

Project 61–i–1, real estate development, Los Alamos, New Mexico, $435,000.

Project 61–i–2, elementary school addition, Los Alamos, New Mexico, $145,000.

Project 61–i–3, steam transmission line, Los Alamos, New Mexico, $135,000.

(j) GENERAL PLANT PROJECTS.—$34,175,000.

SEC. 102. LIMITATIONS.—(a) The Commission is authorized to start any project set forth in subsections 101 (a), (b), (d), (f), and (h) only if the currently estimated cost of that project does not exceed by more than 25 per centum the estimated cost set forth for that project.

(b) The Commission is authorized to start any project set forth in subsections 101 (c), (e), (g), and (i) only if the currently estimated cost of that project does not exceed by more than 10 per centum the estimated cost set forth for that project.

(c) The Commission is authorized to start a project under subsection 101(j) only if it is in accordance with the following:

1. For community operations, the maximum currently estimated cost of any project shall be $100,000 and the maximum currently estimated cost of any building included in such project shall be $10,000.

2. For all other programs, the maximum currently estimated cost of any project shall be $500,000 and the maximum currently estimated cost of any building included in such a project shall be $100,000.

3. The total cost of all projects undertaken under subsection 101(j) shall not exceed the estimated cost set forth in that subsection by more than 10 per centum.

SEC. 103. ADVANCE PLANNING AND DESIGN.—There are hereby authorized to be appropriated funds for advance planning, construction design, and architectural services, in connection with projects which are not otherwise authorized by law, and the Atomic Energy Commission is authorized to use funds currently or otherwise available to it for such purposes.

SEC. 104. RESTORATION OR REPLACEMENT.—There are hereby authorized to be appropriated funds necessary to restore or to replace plants or facilities destroyed or otherwise seriously damaged, and the Atomic Energy Commission is authorized to use funds currently or otherwise available to it for such purposes.

SEC. 105. CURRENTLY AVAILABLE FUNDS.—In addition to the sums authorized to be appropriated to the Atomic Energy Commission by section 101 of this Act, there are hereby authorized to be appropriated to the Atomic Energy Commission to accomplish the purposes of this Act such sums of money as may be currently available to the Atomic Energy Commission.

SEC. 106. SUBSTITUTIONS.—Funds authorized to be appropriated or otherwise made available by this Act may be used to start any other new project for which an estimate was not included in this Act if it be a substitute for a project or portion of a project authorized in subsections 101 (a), (b) and (c) and the estimated cost thereof is within the limit of cost of the project for which substitution is to be made, and the Commission certifies that—

(a) the project is essential to the common defense and security; and

(b) the new project is required by changes in weapon characteristics or weapon logistic operations; and

(c) it is unable to enter into a contract with any person, including a licensee, on terms satisfactory to the Commission to furnish from a privately owned plant or facility the product or services to be provided in the new project.

SEC. 107. AMENDMENT OF PRIOR YEAR PROJECTS.—(a) Section 101 (d) of Public Law 84–506, as amended, is further amended by striking therefrom "Project 57–d–1, high energy accelerator, $27,000,000" and substituting therefor "Project 57–d–1, zero gradient synchrotron, Argonne National Laboratory, Illinois, $42,000,000".

(b) Public Law 86–50 is amended by striking out the figure "$5,000,000" for project 60–e–12, alterations to Shippingport reactor facilities, and substituting therefor the figure "$9,000,000".

SEC. 108. PROJECT RESCISSIONS.—(a) Public Law 86–50, is amended by rescinding therefrom authorization for a project, except for funds heretofore obligated as follows:

Project 60–c–2, special processing plant, phase II, Mound Laboratory, Ohio, $3,800,000.

(b) Public Law 85–590, as amended, is further amended by rescinding therefrom authorization for projects, except for funds heretofore obligated, as follows:

Project 59–b–4, special processing plant, Mound Laboratory, Ohio, $2,000,000.

Project 59–c–8, lineal acceleration tester, Livermore, California, $390,000.

Project 59–g–3, gamma process development irradiator, $1,600,000.

(c) Public Law 85–162, as amended, is further amended by rescinding therefrom authorization for projects, except for funds heretofore obligated, as follows:

Project 58–b–5, additions to scrap plants, various sites, $1,500,000,

Project 58–c–2, weapons special component plant, $6,000,000.

(d) Public Law 84–506, as amended, is further amended by rescinding therefrom authorization for a project, except for funds heretofore obligated, as follows:

Project 57–a–7, modifications to existing production facilities for increased efficiency and safety, Hanford, Washington, $3,000,000.

SEC. 109. COOPERATIVE POWER REACTOR DEMONSTRATION PROGRAM.—(a) Section 111 of Public Law 85–162, as amended, is further amended by striking out the date "June 30, 1960," in clause (3) of subsection (a) and inserting in lieu thereof the date "June 30, 1961."

(b) Section 110 of Public Law 86–50 is amended by striking out the figures $55,500,000" and "$65,500,000" in the first sentence of subsection (b) and inserting in lieu thereof the figures "$95,500,000" and "$110,500,000", respectively; by striking out the figure "$5,000,000" in the last sentence of subsection (c) and inserting in lieu thereof the figure "$20,000,000"; by deleting the word "two" in the first sentence of subsection (d).

(c) The provisions of subsection (e) of section 110 and of section 112 of Public Law 86–50 shall continue to apply to the projects authorized in subsections (b), (c), and (d) of section 110 of Public Law 86–50, as amended by this section.

SEC. 110. COOPERATIVE RESEARCH AND DEVELOPMENT PROGRAM WITH CANADA.—There is hereby authorized to be appropriated to the Commission, in accordance with the provisions of section 261(a)(2) of the Atomic Energy Act of 1954, as amended, the sum of $5,000,000 for use in a cooperative program of research and development in connection with heavy water moderated nuclear power plants to be conducted under the Agreement for Cooperation Concerning Civil Uses of Atomic Energy Between the Government of the United States of America and the Government of Canada, signed on the 15th day of June 1955, as now or hereafter modified.

ANALYSIS OF PROPOSED BILL FOR AUTHORIZATION OF APPROPRIATIONS UNDER SECTION 261 OF THE ATOMIC ENERGY ACT OF 1954, AS AMENDED, FISCAL YEAR 1961

A BILL To authorize appropriations for the acquisition or condemnation of real property or facilities, and for plant or facility acquisition, construction, or expansion for the atomic energy program, for continuation of the cooperative power reactor demonstration program, and for a cooperative research and development program with Canada

The proposed bill would authorize appropriations for additional capital outlays totaling $171,256,000 for the Atomic Energy program. Authorization is required under the provisions of section 261 of the Atomic Energy Act of 1954 (Public Law 703, 83d cong.).

The estimate of appropriations to be authorized in section 101 is based on the following requirements:

Page No.	Project No.	Item	Estimated cost
4	61-a-1	Modifications to production and supporting installations	$10,000,000
5	61-a-2	Billet production plant	1,800,000
6	61-a-3	Heat treatment and inspection modifications, Fernald, Ohio	2,500,000
7	61-a-4	Development laboratory building, Oak Ridge, Tenn	766,000
8	61-a-5	Plutonium reclamation plant, Hanford, Wash	2,900,000
9	61-a-6	Moderator purification improvements, Savannah River, S.C	2,500,000
10	61-b-1	Weapons production, development and test installations	10,000,000
11	61-b-2	High velocity test track, Sandia Base, N. Mex	2,100,000
12	61-b-3	Special metals fabrication plant	3,000,000
13	61-c-1	Tonopah Test Range, Tonopah, Nev	1,900,000
14	61-c-2	Contaminated waste plant, Los Alamos, N. Mex	2,000,000
15	61-d-1	Additions and modifications to Chemical Engineering Building, Argonne National Laboratory, Illinois	2,000,000
16	61-d-2	Special-purpose test installation addition, Santa Susana, Calif	1,200,000
17	61-d-3	Technical space for SPERT, National Reactor Testing Station, Idaho	500,000
18	61-d-4	Critical building, Brookhaven National Laboratory, New York	600,000
19	61-d-5	Fast reactor core test installation, Los Alamos Scientific Laboratory, New Mexico	6,900,000
20	61-d-6	Plutonium fuel service and development building, Los Alamos Scientific Laboratory, New Mexico	600,000
21	61-d-7	Test installation for Project Rover	20,000,000
22	61-d-8	Test installation for Project Pluto	15,000,000
23	61-d-9	Advanced test reactor	24,000,000
24	61-e-1	Additions and modifications, MTR-ETR area, National Reactor Testing Station, Idaho	800,000
25	61-e-2	Site utilities, Brookhaven National Laboratory, New York	1,250,000
26	61-e-3	Quarters for visiting scientists, Brookhaven National Laboratory, New York	550,000
27	61-f-1	Bubble chamber house, Brookhaven National Laboratory, New York	1,660,000
28	61-f-2	Princeton-Pennsylvania accelerator addition, Princeton, N.J	1,350,000
29	61-f-3	Accelerator and reactor additions and modifications, Brookhaven National Laboratory, New York	1,285,000
30	61-f-4	High flux isotope reactor, Oak Ridge National Laboratory, Tennessee	12,000,000
31	61-f-5	Accelerator improvements, Lawrence Radiation Laboratory, California.	950,000
32	61-f-6	Bevatron shielding, Lawrence Radiation Laboratory, California	1,100,000
33	61-g-1	Metallurgy building extension, Brookhaven National Laboratory, New York.	655,000
34	61-g-2	Addition to cyclotron building, Lawrence Radiation Laboratory, California.	500,000
35	61-h-1	Installations for support of biomedical research in atomic energy	4,000,000
36	61-i-1	Real estate development, Los Alamos, N. Mex	* 435,000
37	61-i-2	Elementary school addition, Los Alamos, N. Mex	145,000
38	61-i-3	Steam transmission line, Los Alamos, N. Mex	135,000
39	61-j	General plant projects	34,175,000

In addition, the proposed bill includes the following:

Page No.	
40	Sec. 107, project 57-d-1, zero gradient synchrotron, Argonne National Laboratory, Illinois (formerly high energy accelerator) (amended authorization).
42	Sec. 107, project 60-e-12, alterations to Shippingport reactor facilities (amended authorization).
43	Sec. 109, cooperative power reactor demonstration program (amended authorization).
44	Sec. 110, cooperative research and development program with Canada.

61-a-1. Modifications to production and supporting installations, $10 million

This project provides for the design, procurement, fabrication, and installation of equipment, together with the necessary plant modifications to existing facilities and/or construction of new facilities necessary to guarantee the continuity of operation, incorporation of technological advances, and increased safety of operations and assure the most economical operation of the production and supporting facilities under the administration of the Hanford, Savannah River, and Oak Ridge operations offices.

As in the case of the general plant projects, many of the items to be performed under this project cannot be identified specifically in advance, their need being predicated on the progress of process development work and changes in program requirements. Examples of work which may be done under this

project are: Self-supported fuel element facilities; reactor modifications for self-supported elements; new effluent systems, reduction of radiation exposure; heavy water conservation; underwater fuel element examination facilities; continuous denitration; high temperature test loops; and other items as the need arises.

61–a–2. Billet production plant, $1,800,000

This project provides for metal-production facilities necessary for the fabrication of billets for the Hanford new production reactor (NPR) either by expanding an existing plant at Fernald or constructing a new building of about 20,000 square feet at Fernald or another AEC site. The problem of isotopic crossover is one of the factors that will enter into the determination to build a new building or add on to an existing one.

In any event the modified facility will require equipment for these major process steps—reduction, recasting, and machining.

Since the first reactor loading will be required in late calendar year 1962, the initial equivalent quantity of slightly enriched uranium billets will be required in early calendar year 1962, therefore, construction of this facility must begin in fiscal year 1961.

61–a–3. Heat treatment and inspection modifications, Fernald, Ohio, $2,500,0000

This project is to provide capital improvements, modifications, and additions to existing fuel element fabrication facilities. Requirement for modification and additions arise from the need for heat treating, inspection and machining facilities designed specifically to meet current specifications and to provide some flexibility for coping with expected future changes in metal specifications.

The building additions are expected to total approximately 48,300 square feet. Other necessary work includes relocation and alteration of existing utilities, construction of additional roadways, and other related work.

61–a–4. Development laboratory building, Oak Ridge, Tenn., $766,000

This project provides for the construction of a laboratory-type building having approximately 24,000 square feet gross area.

The new building is required to replace a wartime structure inadequate for present and future process development programs for the Oak Ridge and Paducah gaseous diffusion plants. In addition to being designed from the standpoint of its function it will provide sufficient flexibility to allow its adaptation to the future development program as well as those currently underway.

61–a–5. Plutonium reclamation plant, Hanford, Wash., $2,900,000

This project will provide a new improved facility for reclamation of plutonium from both wet and dry wastes which originate in the purification and fabrication operations. The facility, which will be adequately shielded, will be housed in a new reinforced concrete building.

61–a–6. Moderator purification improvements, Savannah River, S.C., $2,500,000

This project provides for improvements and additions to the moderator purification facilities in the Savannah River reactors in order to reduce the amount of particulate matter in the moderator-coolant and to reduce the turbidity in the moderator by removing radioactive particles.

61–b–1. Weapons production, development, and test installations, $10,000,000

This project provides for the construction and acquisition of such additional production, development, and test facilities as may be required to further the weapons program. The specific nature of these facilities cannot be forecast at this time; however, the magnitude of the future production and development programs indicates that additional facilities will be required, either in the way of increased plant capacity or added plant or facilities needed to cope with new techniques or both. This project will assure availability of funds to meet new production requirements and to provide research, development and test facilities in order to take early advantage of advances or changes in the weapons field.

61–b–2. High velocity test track, Sandia Base, N. Mex., $2,100,000

This project provides for the construction of a test track of approximately 10,000 feet and supporting structures. The supporting structures include power-outlet stations, setup shelter, and rain-erosion facilities.

The dynamic testing of materials and components is a vital link in the successful development of a weapon. Such tests include aerodynamic studies,

environment experiments, parachute ejection studies, impact tests, safety experiments, and water entry tests. The only facility available at Sandia to conduct these tests is a 3,000-foot track which is expensive to operate and technically inadequate. The major limitations which make the existing track unsuitable are: (1) inability to reach required speeds of mach 3 to 3.5 and (2) the time period during which high velocities can be maintained is insufficient to accumulate necessary diagnostic data. The proposed 10,000-foot track will make it possible to attain the required speeds and sustain the high velocities for a period of time sufficient to accumulate needed information.

61–b–3. Special metals fabrication plant, $3 million

This project provides for a special metals fabrication plant consisting of a machine shop area, a press and salvage area, a brazing and annealing area, changehouse, lunchroom, and administrative area. Major equipment items are vertical and horizontal lathes, 1,000-ton press, resistant-type vacuum furnaces and cleaning and salvage equipment.

61–c–1. Tonopah test range, Tonopah, Nev., $1, 900,000

In fiscal year 1959, observation stations with associated instrumentation and other minor buildings and utilities were installed at the Tonopah Test Range for $460,000. This phase II project adds high-speed radar coverage; tracking stations to extend range and increase safety and data acquisition; new blockhouse and rocket-launching facilities; administration building at control point; repaving of access road; and utility improvements.

The additional instrumentation provided by this project will extend the range systems data collection capability in terms of range, speed and altitude for both aircraft and rocket tests. Weapons requirements, involving weapons at supersonic velocities, are dependent upon this range development for successful evaluation of weapons performance after release at either high or low-level altitudes.

61–c–2. Contaminated waste plant, Los Alamos, N. Mex., $2 million

This project provides for the construction of a plant for the treatment of chemically and radiochemically contaminated liquid wastes generated by the metallurgical, chemical biological, and cryogenical laboratories at the Los Alamos Scientific Laboratory. It will replace an existing disposal plant which was originally constructed as a pilot plant but through modifications has been able to handle the current load of 120 gallons per minute for an 8-hour day.

New and greatly augmented waste treatment requirements, estimated at 200 gallons per minute, are now projected based on laboratory facilities becoming available, primarily in the nuclear propulsion and power reactor programs, in 1960, 1961, and 1962. Furthermore, the existing plant was designed to handle plutonium and other alpha emitter wastes whereas the reactor program wastes contain mixed fission products and the present treatment system can remove only a small fraction of such wastes.

It is planned, therefore, that the new facility will have an estimated capacity of 250 gallons per minute and will consist of chemical treatment for the removal of alpha emitters followed by an ion-exchange treatment for removal of fission products. It will include facilities for consolidation and modest expansion of ecology and environmental research by the laboratory's radiological physics group, for continued waste disposal research by the industrial waste group, and for radiological decontamination of equipment and materials by the monitoring group.

61–d–1. Additions and modifications to chemical engineering building, Argonne National Laboratory, Illinois, $2 million

This project provides for the extension of the ANL Chemical Engineering Building and includes provision for a gamma analyzer facility. The project will provide laboratories to permit much needed extension of the program in the areas of pyrometallurgy, high temperature processes and materials, and applied plutonium and fluorine chemistry. The existing laboratory areas are extremely crowded, and other areas have been converted to laboratory use to the maximum extent possible. This crowding results in the lack of space for additional equipment and personnel and hampers present programs and limits the ability to undertake new work. The greatly needed gamma analyzer facility will be most economical to build as a part of this construction.

61–d–2. Special purpose test installation addition, Santa Susana, Calif., $1,200,000

The purpose of this project is to provide a testing capability for the SNAP program. It will include an additional power test cell and a transfer lock which will have larger work areas, heavier shielding to accommodate higher radiation levels, and provisions for dissipation of the greater heat rate. Necessary supporting building space and facilities will be provided to include machinery for greater heat removal capacity, additional mechanical, electrical and compressor-room equipment, control-room console, storage space and utilities.

The SETF (SNAP environmental test facility) has at present a capability of full system and simulated environmental testing of low-powered SNAP systems. The AEC has a requirement to extend the SNAP 2 reactor development to the 500 thermal kilowatt range for certain advanced space missions. The new cell complex is required to permit full system testing of these units.

In addition to the higher power requirement, the number of SNAP 2 reactor application development programs necessitates the concurrent testing of units and, therefore, an increased testing capability. The objectives of high operational reliability for periods of 1 to 2 years in space missions is also requiring longer periods of testing as well as testing under a variety of simulated conditions. These factors all contribute to the need for additional environmental testing capability to be made available during fiscal year 1961.

61–d–3. Technical space for SPERT, national reactor testing station, Idaho, $500,000

This project provides for the design and construction of a building of approximately 10,000 square feet to be used as the control center for the SPERT projects. The building will provide space for technical personnel, including laboratory facilities and supporting areas.

The building is required to accommodate the expanded staff of technical and support personnel who are responsible for the SPERT program. The SPERT program involves 2 operating reactors at the present time with approximately 60 technical and administrative personnel. This staff will grow to a total of approximately 110 people within the next 2 years due to the startup of SPERT II in 1959, and SPERT IV in 1960 which will place an increased burden upon test operations, data reduction, and the analysis of results. The staff is presently housed in a series of Butler buildings which are highly cramped with equipment allowing only 45 square feet of office space for technical personnel. The SPERT program is the only major reactor program throughout the world which is completely devoted to the study of reactor safety and is vitally important in its role of eventually providing for safe and economical reactor power.

61–d–4. Critical Building, Brookhaven National Laboratory, New York, $600,000

The BNL Critical Building will be attached to existing experimental reactor physics facilities. It will have an area of approximately 10,000 square feet and will contain a critical experiment area and a support area.

The critical experiment area will have a shielded critical assembly cell with an approximate 30-foot clear height. The cell will be separated from the control console room by an entrance labyrinth. The shielding will be used to protect personnel in adjacent facilities from accidental radiation bursts.

The support area will contain office space, a shielded room for low-level counting, a vault for storing critical experiment fuel, an emergency power supply, a small boiler plant, and a basement storage area.

The BNL reactor physics program has produced a number of exponential experiments performed since 1951 and these have been the main U.S. source of fundamental experimental information on low enrichment, light water moderated reactor lattices. However, with the continual advance in sophistication and complexity of core design, modern reactor cores are no longer amenable to study by exponential experiment techniques. Many multiregion fuel loadings and nonuniform burnable poison distributions must be studied by critical experiment techniques. This facility is, therefore, essential to permit BNL to develop necessary reactor physics information for use in the design of reactor cores.

61–d–5. Fast reactor core test installation, Los Alamos Scientific Labortory, New Mexico, $6,900,000

This project will provide a building and plant for the test operation of new types of fast reactor cores and the disassembly and analyses of such cores after operation. The project consists of two parts: (1) building construction and (2) reactor fabrication and installation. It is proposed to start construction of this building in fiscal year 1961 for the purpose of housing the proposed LAMPRE II reactor installation. The building will be designed and constructed so that a succession of different core concepts can be studied with the minimum rearrangement of the main plant. It will be an economical industrial-type structure consisting probably of a structural steel frame with insulated cement asbestos siding or concrete masonry blocks which will match existing structures. One of the prime problems in the development of fast breeder cores is the attainment of high specific power and power density. Another problem is the development of liquid fuel container materials and fabrication methods suitable for the necessary high temperature and heat flux. This faciilty will permit testing of cores and material to obtain data for the Commission's reactor program.

61–d–6. Plutonium Fuel Service and Development Building, Los Alamos, Scientific Laboratory, New Mexico, $600,000

This project provides for an addition to the DP-West Plant at TA–21. The addition will be similar in construction and size to the other five buildings at this site and will be connected to them by a corridor.

To date, it has been possible to carry out small-scale alloy-fuel development and to furnish the LAMPRE program with test alloys, using existing LASL facilities. More elaborate experiments and more complex alloys of compositions suitble for a larger reactor of the LAMPRE type will preclude the use of the present fabrication line facility and will require additional space in which to fabricate fuel components for various tests for the expanded experimental program.

61-d-7 Test installation for project Rover, $20 million

This project provides for the construction and modification of laboratory research facilities at Los Alamos, reactor field testing facilities at the Nevada test site, and such other facilities as may be required to support the Los Alamos Scientific Laboratory nuclear rocket propulsion program (Project Rover).

This project will provide (1) modifications, improvements, and expansion of existing structures to provide greater flexibility of use and to permit the conduct of low power reactor experiments of advanced and improved reactors and (2) new construction, including a test cell and related support construction for experiments at higher power levels.

61–d–8. Test installation for Project Pluto, $15 million

This project provides for the modification and additions to the existing Pluto test facility to accommodate the testing of the Tory II–C reactor experiment. The advanced Tory II–C reactor will be of the high-power, high-temperature aircooled type, and a considerably larger air supply to give the higher flow rates and longer durations will be necessary to meet these requirements. In view of the experimental nature of the program and the need for extensive environmental testing of the advanced reactor core, an additional test point is required. The major element of cost is associated with the air storage and air heating systems. Modification of the disassembly facility and additional supporting facilities, utilities, roads and paving also will be required.

The effort in fiscal year 1960 will be directed primarily toward initiation of tests of the first experimental device (Tory II–A) at the Nevada test site (NTS) in special facilities now under construction for that purpose.

The requested facilities will be designed to accommodate the design point testing of the advanced reactor cores for Tory II–C.

61–d–9. Advanced test reactor, $24 million

This project provides for the construction of an advanced test reactor to provide high fluxes. High fluxes are required for the Commission program to develop high performance naval and power reactors. The design power level of the reactor has not been established. However, a conceptual design study is underway to establish the parameters for an advanced test reactor.

It is intended that the reactor will be optimized to meet pressurized water reactor test requirements.

61–e–1. Additions and modifications, MTR–ETR area, National Reactor Testing Station, Idaho, $800,000

This project consists of a structure of approximately 31,000 square feet, including a basement of approximately 1,000 square feet to house heating and mechanical equipment. The building will be an extension to the present Reactor Services Building.

This facility will provide work space for about 200 engineers, draftsmen, and sponsor representatives presently housed in several remote and severely crowded facilities. It will also make available a classified storage vault which will stock classified documents for the technical library which are now housed in a storage valult for reactor fuel elements and classified experimental subassemblies.

61–e–2. Site utilities, Brookhaven National Laboratory, New York, $1,250,000

This project consists of two parts: (*a*) the first has to do with the steam (heating) distribution system of the laboratory; it includes primarily increasing the carrying capacity of the steam lines to correspond to the increased demands and the increased steam generating capacity of the central steam plant; and (*b*) the second part deals with the electrical distribution system; it consists of doubling the capacity of the main transformer substation and extending and enlarging the underground duct bank system.

The immediate specific need is concerned with the utilities for projects presently underway or recently completed (e.g., AGS accelerator, Cosmotron Target Area) or for authorized building and projects which will be either in the active design stage or under construction in the coming year (e.g., Research Rector, Physics Building, Nuclear Engineering Building).

The work will consists of (1) increasing the capacity of the steam lines by extension of underground distribution mains (2) increasing the main transformer substation (3) extending the underground electrical duct bank system.

61–e–3. Quarters for visiting scientists, Brookhaven National Laboratory, New York, $550,000

This project provides for the construction and furnishing of 56 units (48 one-room and 8 two-room). The units will be contained in buildings which will be located near existing temporary apartments on the outskirts of the Brookhaven National Laboratory property. The apartments are necessary primarily to meet the housing demands of visiting scientists. The units will also be utilized for Laboratory staff employed on on-call basis.

The Laboratory is located in a remote area of Long Island, N.Y., where houses and apartments are not generally available on a short-term rental basis. A principal objective of the Laboratory is to make its unusual and extensive research facilities available to the scientific community as a whole. In pursuit of this objective the Laboratory has encouraged scientists from universities, industry, Government laboratories, and other institutions to work at Brookhaven for extended periods of time. As a result of this highly effective program, more than 500 visiting scientists spend 1 month or more at the Laboratory each year. These include approximately 300 mature scientists from other institutions, between 75 and 100 postdoctoral research associates, 30 graduate students working on doctoral theses, and 100 students participating in the summer program. The average attendance from all of these sources is approximately 225 with, of course, a peak during the summer months.

This program is extremely valuable from several viewpoints. It gives the Laboratory the services of large numbers of experienced scientists whose presence not only augments the work accomplished but also contributes important intangible benefits from the exchange of ideas. The experience and training acquired by the younger visitors greatly strengthens the total national scientific program through the increased effectiveness of the visitors when they return to their home institutions. Furthermore, in many instances universities are able to attract and keep distinguished scientists because of the research opportunities afforded at Brookhaven.

61–f–1. Bubble Chamber House, Brookhaven National Laboratory, New York, $1,660,000

This project covers the construction of a building to house the 80-inch bubble chamber, an AGS tunnel conjunction section necessary to bring elementary particle beams to the bubble chamber, the required exterior yard areas, and site

and utility work. High density concrete shielding is included for the bubble chamber.

Liquid hydrogen bubble chambers are among the most powerful tools for experimentation in high energy physics. A chamber of dimensions 80 by 25 by 20 inches is now being built at BNL for use at the alternating gradient synchrotron (AGS). In this chamber production, interactions, and properties of elementary particles, such as nucleons, mesons, and "strange" particles, are to be studied in liquid hydrogen and deuterium. The large size of the chamber is dictated by the high energies, made possible by the AGS, of many of the particles which are to be studied.

The bubble chamber will reach the testing stage in fiscal year 1961 and a structure to house it as well as its auxiliary equipment is required. The bubble chamber and auxiliary equipment will be so large that it cannot be placed inside the existing AGS target building as it would interfere seriously with the array of magnets necessary to provide beams, and with other experiments. Furthermore, any location near the existing target area would produce a serious impediment, not so much by the chamber itself but by the large number of bending and focussing magnets and beam separators required to guide secondary and external primary beams into the bubble chamber.

61–f–2. Princeton-Pennsylvania accelerator addition, Princeton, N.J., $1,350,000

This project provides for construction of a new administrative, maintenance, and laboratory wing and of a new storage building. The new wing, comprising the major portion of this project, will be a building designed to house the operating and maintenance staff, purchasing department, machine shop, administrative staff and some of the laboratories and experimental facilities. The storage building will have an area of about 20,000 square feet and will cost about $110,000. These building additions will be located on long-term leased or purchased land.

A new wing is needed because the present office and laboratory building is already 100 percent occupied by accelerator engineering staff, administrative staff, and supporting functions numbering 96 people. An increase in staff of approximately 30 faculty members and 20 graduate students by July 1960 is expected. These physicists are now planning experiments at the University of Pennsylvania and Princeton, but will have to be accommodated at the accelerator if they are to function most effectively. The present building of 28,000 square square feet, being immediately adjacent to the accelerator proper, is the ideal place to house the scientific staff and their complex experimental equipment.

A new storage building is needed since at the present time there is no storage area available of sufficient size to store bulk materials and auxiliary equipment temporarily out of use.

61–f–3. Accelerator and reactor additions and modifications, Brookhaven National Laboratory, New York, $1,085,000

This project provides for recurring annual projects of varying magnitude to take care of inevitable necessary changes and additions to the major research machines at Brookhaven: the graphite reactor, the cosmotron, and the alternating gradient synchrotron. In general, this type of item cannot be established in all details in advance.

Tentative plans for fiscal year 1961 include the following:

Research reactor filters.—This project provides for more efficient filters in the air exhaust ducts system of the research reactor, this filter changeover has been suggested by the Hazards Evaluation Committee.

Cosmotron.—The new experimental facilities of this accelerator make possible new types of experiments and a multitude of secondary and primary particle beams. These require a large number of focusing and deflecting magnets. Power supplies for many of these magnets will have been acquired in previous years. Some additional sets will be required in fiscal year 1961. New straight sections are necessary for both operational and experimental reasons. These new straight sections will be larger and thus provide considerably better experimental facilities; furthermore, they will be designed to improve mechanical stability at the ends of the quadrants.

Alternating gradient synchrotron.—This project will provide for beam separators, power distribution and switchgear for experimental equipment, experimental power supplies, 2 megawatts (rotating equipment only; rectifier power supplies on trailers are included in capital equipment budget), fixed steel and concrete shielding.

61–f–4. High-flux isotope reactor, Oak Ridge National Laboratory, Tennessee, $12 million

This project provides for construction at ORNL of a high-flux reactor of the flux-trap type, operating at a design power of 100 megawatts with a maximum flux in the region of 3–5 by 10^{15} neutrons per square centimeter per second for the production of transuranic elements and special isotopes of the lighter elements. The high-flux isotope reactor (HFIR) will serve as a national facility for the production of transuranic elements. In addition, the project will provide ORNL with a means for expanding and improving its radioisotope program.

The importance of high neutron flux research reactors for the production of heavy elements such as californium 252 and other isotopes, for radiation damage experiments and for neutron beam research has been actively discussed in the national laboratories and other U.S. laboratories for some time.

It has been determined that an isotope producer reactor should be designed and constructed at ORNL. This decision on location was based on (1) availability of facilities for processing and distributing the products of the irradiation, (2) availability of fuel reprocessing facilities, (3) the recognition that ORNL is a national center for isotope research and development, and (4) interest in the Laboratory in constructing the reactor. This reactor would serve as the first AEC-wide high-flux facility and be operated in conjunction with the national heavy element production program.

61–f–5. Accelerator improvements, Lawrence Radiation Laboratory, California, $950,000

This project provides for improvements and additions to the major operating Berkeley accelerators, the Bevatron, the 184-inch cyclotron, and the heavy ion linear accelerator. The requested improvements and additions are primarily of an experimental nature, involving a varied application of engineering-design and equipment usage, including equipment installation for varying periods of time.

An accelerator improvements project was first requested for fiscal year 1958 as part of a project extending over 3 years at a total requested level of $2,200,000. An appropriation in the latter amount will be fully committed and substantially expended by the end of fiscal year 1960. Although construction funds for accelerator improvements will be nearly depleted by the end of fiscal year 1960, programmatic developments have determined a need for a continuous accelerator improvement activity. The effectiveness of accelerators cannot be realized in their full scientific potential without continuous modification to maintain the pace of physical and technological advancements.

61–f–6. Bevatron shielding, Lawrence Radiation Laboratory, California, $1,100,000

This project consists of the design, fabrication, and erection of additional Bevatron shielding required to provide adequate protection from radiation levels. The work will consist of floor alteration, foundations, shielding, roof supports in the injector and wind tunnel area, and roof alterations necessary to accommodate the heavy loads of the planned shielding.

The shielding will provide for sufficient protection for the present operating levels of the machine (peak levels of 10^{11} protrons per pulse). Long-range plans call for further increasing the Bevatron beam intensity to 10^{13} protons per pulse, and provision will be made under this project for foundation and support structure work capable of accepting further necessary shielding at a later date.

At present, the maximum beam intensity of 2 by 10^{11} protons per pulse sustained at 10 pulses per minute produces the maximum radiation level permissible for personnel. Since the level is above this in some parts of the building, this limitation interferes with operations and work scheduling around the Bevatron, and additional shielding is urgently needed.

61–g–1. Metallurgy Building extension, Brookhaven National Laboratory, New York, $655,000

This project consists of two parts: modifications to the existing building and construction of an addition to the building. The existing Metallurgy Building (Bldg. 480), to which this proposed project will be attached, is a cement-block structure, built by the Army as a Camp Upton gymnasium, and modified by the Laboratory for metallurgy work in 1951. The existing building has a gross area of 17,200 square feet.

The modifications to the existing building will consist largely of partition work, including new doors and windows where required, and rearranging utilities (water, gas, steam, electric power, drains, etc.) as required to accommodate the new functions in these spaces. The extension will be made at the eastern, two-story end of the existing building, and will be a structure having a gross area of approximately 12,200 square feet.

The proposed addition to the Metallurgy Building and the modifications to existing spaces are intended to provide facilities not now included, and also to relieve the severe overcrowding of existing facilities.

61–g–2. Addition to Cyclotron Building, Lawrence Radiation Laboratory, California, $500,000

This project comprises an additional 9,000 gross square feet of experimental area for the 184-inch cyclotron by providing an addition to the existing Building 6. The addition will be an extension of the southern side of the present building by approximately 32 feet through approximately 128° of arc.

The experimental physics program and the 184-inch cyclotron activity are severely limited by insufficient experimental space in the existing building. The machine has not been able to attain its maximum operating level, nor have the experimenters been able to achieve the maximum yield of information from the instrument. At present, the feasibility of an experiment is controlled not by its scientific importance or the capacity of the cyclotron to carry it through, but whether there is adequate space to set up the necessary equipment. This kind of limitation is one that can and should be eliminated to take full advantage of manpower and machinery.

61–h–1. Installations for support of biomedical research in atomic energy, $4,000,000

This project provides for construction, alternation, and modification of laboratory and animal holding installations as may be required for support of biomedical research in atomic energy. Existing Commission-supported laboratories are in many instances inadequate for the conduct of biomedical research programs required for the initiation or expansion of investigations of the effects of radiation on biological systems and hazards associated with radioactive fallout and other atomic energy operations. These laboratories will be enlarged where required, and other installations will be provided when existing facilities are not available, or are inadequate.

The need for expansion of installations required for support of biomedical research programs has been emphasized during the hearing conducted in May 1959, by the Joint Committee on Atomic Energy, updating information on radioactive fallout and defining new problems requiring further investigation. Studies planned include research on the production of tumors with chronic doses of radiation, experimental radiation dosimetry and animal radiobiology using fast neutrons only slightly contaminated by gamma radiation and in a short pulse time, effects of small amounts of irradiation on longevity, biochemical and genetic effects of radiation at the cellular level, and effects of inhalation of mixed fission products.

Most of these projects require unique installations for delivery of radiations and for retention of experimental animals and other biological materials for long periods of time. These laboratories and animal holding quarters are not ordinarily available in Commission or university locations.

61–i–1. Real-estate development, Los Alamos, N. Mex., $435,000

This project provides for the development of 73 additional lots on Barranca Mesa, which lies immediately north of, and in proximity to, the main Los Alamos community. The development has been desgined to conform with FHA subdivision requirements as to physical improvements, utilities, and lot layout. The estimate covers the cost of providing the necessary utilities, roads, and lot development.

Adequate housing has long been known to be a prime consideration in the attraction and retention at Los Alamos of the high-caliber technical and scientific personnel required to conduct the programs at the Laboratory. This project, which continues a program now underway, will enable Los Alamos personnel to build the size and type of housing they desire. Moreover, it will make it possible for Laboratory personnel to spend their full working careers at Los Alamos with assurance of being able, upon retirement, to remain residents of the community. The program has the further advantage of partially meeting the need for improved housing at Los Alamos on a basis which will permit the Government to recover development costs through revenues from sale of lots and utilities.

This project is the third increment of the lot development on Barranca Mesa. The first increment has just been completed and all 72 lots sold. Development of the second increment (47 lots) has begun.

61-i-2. Elementary school addition, Los Alamos, N. Mex., $145,000

This project provides for an addition to the Mountain Elementary School of four special-purpose classrooms, having a total area of approximately 7,200 square feet. Space currently used for such activities is substandard in size (3,000 square feet) and type of space in comparison to other Los Alamos schools. In addition, it is expected that the enrollment at the Mountain School will have increased by 100 students by the time the addition is complete. This addition will therefore permit converting the space now used back to regular classrooms which will be needed for the enrollment increase as well as to correct deficiencies in the special classroom needs.

61-i-3. Steam transmission line, Los Alamos, N. Mex., $135,000

The steam requirements of the central community area are now met by a small plant constructed in 1948. The cost of producing steam at this plant is $1.51 per 1,000 pounds as compared with a cost of $0.31 per 1,000 pounds at another steamplant which has been recently completed in a nearby technical area. This project will provide for the construction of approximately 3,500 feet of steam line, thereby making it possible to serve the central community area with steam from the technical area and place the small plant in standby. This change will reduce annual operating costs by approximately $45,000.

61-j. General plant projects, $34,175,000

These projects provide for the many miscellaneous minor alterations, additions, modifications, replacements, and minor new construction items required annually by each of the Commission's operating programs to provide continuity of operation, improvement in production techniques, road and street improvements, elimination of health and safety hazards, minor changes in operating methods and to protect the Government's investment by preventing excessive deteriorations and obsolescence in the facilities which support the several programs of the Commission.

The criteria under which funds are expended are (*a*) in connection with community operations, no single project can exceed a cost of $100,000 and no new or expanded building in connection with such project can exceed a cost of $10,000; (*b*) in connection with all other programs, the maximum prjoect cost is $500,000 and the maximum building cost is $100,000.

The estimate for fiscal year 1961 general plant projects is based on experience in prior years and takes into account new plant and other facilities which are coming into operation, and certain special nonrecurring projects which, because of their nature, fall within the criteria for general plant projects.

By program, the estimated requirements for fiscal years 1960 and 1961 are:

Program	Fiscal year 1960	Fiscal year 1961
Raw materials	$100,000	$100,000
Special nuclear materials	10,400,000	11,500,000
Weapons	8,000,000	8,500,000
Reactor development	7,500,000	9,000,000
Physical research	2,500,000	3,500,000
Biology and medicine	382,000	300,000
Training, education, and information	100,000	150,000
Community	1,050,000	525,000
Administrative	691,000	600,000
Total	30,723,000	34,175,000

Section 107: Project 57-d-1. Zero gradient synchrotron, Argonne National Laboratory, Illinois, $42 million

This project provides for the design and construction of a high intensity high energy proton synchrotron (approximately 12.5 billion electron volts) and related laboratory and experimental areas at the Argonne National Laboratory. A high energy accelerator project was authorized in fiscal year 1957 (project 57-d-1) for $15 million. The justification for that project was made on the basis of an urgent short-range need for extending the energy range beyond that of presently available machines. The site and specifications for the machine were undetermined at the time of its authorization.

Subsequent to the authorization of that project, the Argonne National Laboratory was selected as the site for this machine and a study was conducted to determine what type of an accelerator could be built for $15 million. It was found that any accelerator built for this amount would be essentially a duplication of an existing machine or one already under construction in the United States. Accordingly, the desirability of constructing such a machine was reconsidered, especially in light of the fact that the National Science Foundation's Advisory Panel on High Energy Accelerators had recently recommended that first priority be given to those machines that give promise of extending the important accelerator parameters to new ranges. As a consequence, it was decided to increase the authorization for this project to $27 million in the fiscal year 1958 authorization act. The last cost estimate submitted to the Congress was $29 million included in the fiscal year 1960 congressional budget submission.

Work has proceeded under the fiscal year 1958 authorization, and as of October 31, 1959, design was 32 percent complete and construction was 3 percent complete. A recent review of the project has been made, and it has been determined that the high energy facilities associated with the machine should be provided now and the scope increased. These additional facilities need to be constructed simultaneously with the basic project in order to utilize as soon as possible the machine's full potential for making significant contributions in the field of high energy physics. Construction of these facilities now would also avoid serious interference with the operation of the machine that would occur if these items were to be delayed. An increase in the authorization to a total of $42 million is requested.

The increase will provide for significant additions to the experimental facilities and related power supplies, cooling systems and machine controls. Also included are relatively minor improvements to the operating capabilities of the synchrotron. The major items of these additional facilities are: modifications to the meson shield wall, external experimental proton areas A–1 and A–2, power building for the meson area and proton area A–1, power building for proton area A–2, cooling system additions, additions to the main substation, additions to the main power building, additions to the shop and assembly building, site improvements and utility extensions, additional machine and beam controls, a bubble chamber building, and a cryogenics facility.

This project will provide a much-needed high-energy accelerator in the Midwest at an energy and intensity not otherwise available in the United States. The proposed machine will provide a copious source of antiprotons and antineutrons and will thus open the whole field of "antimatter" reactions for precise experimentation. The Bevatron has permitted the discovery of these particles but its energy range is too low for their production on a scale for precise experimentation. The intensity of the machine will be capable of producing a beam containing 10^{13} particles per minute, which is greater by a factor of 15 or 20 than that expected to be produced by the alternating gradient synchrotron now under construction at the Brookhaven National Laboratory.

Section 107: Project 60–e–12. Alterations to Shippingport reactor facilities, $9 million

This project provides for modification to the Shippingport Atomic Power Station at Shippingport, Pa., in order to permit operation at a power level sufficient to generate 150-megawatt gross electrical output. Modifications will consist of required changes in certain components and systems of the reactor plant, primarily pressurizer and pressure relief system, steam generators and instrumentation and control systems and provision for dissipation of excess steam above present generating capacity which is now rated at 100-megawatt electric.

The Shippingport plant was constructed to obtain information relative to the design, operation, and maintenance of central station nuclear powerplants with the primary objective of advancing general power reactor technology. The development of longer life, high power density cores is a major goal in this effort. Core 2 is of such a design that it is expected that this core will have sufficient capacity for generation of approximately 150-megawatt gross electrical output. In order to take advantage of the higher anticipated performance of core 2 and to demonstrate the maximum power capability that can be obtained from a primary system of the size and design of the reactor installed in the Shippingport plant, it is necessary to make these plant modifications.

This authority is necessary in the event negotiations now underway with the Duquesne Light Co. to furnish the additional generating capacity are unsuccessful.

Section 109: Cooperative power reactor demonstration program, $40 million

It is proposed that an additional appropriation authority of $40 million and additional waiver authority of $5 million be made available in fiscal year 1961 to augment the continuing cooperative power reactor demonstration program. For this purpose section 110 of Public Law 86–50 would be amended by increasing the figures in subsection (b) of $55,500,000 to $95,500,000 and of $65,500,000 to $110,500,000. It is also proposed that the authority in subsection (c) to provide research and development assistance in support of unsolicited proposals from the utility industry to construct nuclear power plants be increased from $5 million to $20 million.

It is contemplated that the additional $40 million appropriation authority would be used as follows:

(*a*) Twenty-five million dollars would be used to construct an intermediate-size organic-cooled reactor should the invitation to the utility industry to construct such a reactor not be accepted. Alternatively should the utility industry construct this reactor, another reactor concept may become sufficiently developed to warrant prototype construction during the year. Such possibilities include construction of a spectral shift pressurized water reactor, or construction of a small reactor at a remote location.

(*b*) Fifteen million dollars would be available to support unsolicited proposals from the utility industry to construct large-size reactors. Reactor manufacturers have recently announced their readiness to construct large-size reactors under terms which may warrant one or more utility companies to initiate construction. In addition, the utility industry is studying various reactor concepts and may propose construction of prototypes of such concepts. In such event it would be desirable for the Commission to have authority to provide research and development assistance as necessary to achieve an advancement in the reactor art. The $5 million authority currently available will be employed in the support of the consumers boiling water reactor project. While it is believed that $15 million may be necessary should two or more unsolicited proposals be received, alternatively all or part of such authority could be used to support a third-round invitation for the construction of a prototype of one of the reactor concepts now being studied, should construction of a prototype be desirable.

Section 110: Cooperative research and development program with Canada, $5 million

Under the Agreement for Cooperation Between the Governments of the United States and Canada on the Civil Uses of Atomic Energy, signed on June 15, 1955, Atomic Energy of Canada Limited (AECL) and the USAEC have been assisting each other in a cooperative program of research and development on heavy water moderated power reactors by means of: (1) The exchange of information on design, construction, and operation of current and projected heavy water moderated power reactors in the programs of both countries; and (2) research and development programs common to this type of reactor.

The scope of this joint program to advance heavy water moderated reactor technology is now envisioned to include research and development leading to the design and construction of specific reactors planned or to be programed in the Dominion of Canada. The implementation of the expanded cooperative program will be mutually beneficial to both countries in achieving the objectives of their respective atomic energy programs.

U.S. Atomic Energy Commission,
Washington, D.C., March 1, 1960.

Hon. Clinton P. Anderson,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

Dear Senator Anderson: By letter of January 19, 1960, Mr. Ramey requested data similar to that printed on pages 159 through 172 of the hearings on the 1960 Authorization Act. This material has been brought up to date and is transmitted herewith.

Sincerely yours,

(Signed) A. R. Luedecke,
General Manager.

Enclosure: Status of construction projects and other data for use in conjunction with the fiscal year 1961 authorization bill.

U.S. ATOMIC ENERGY COMMISSION—STATUS OF CONSTRUCTION PROJECTS AND OTHER DATA FOR USE IN CONJUNCTION WITH THE FISCAL YEAR 1961 AUTHORIZATION BILL

TABLE 1A.—*Current estimated costs of active authorized projects compared with estimated costs shown in authorizations enacted pursuant to sec. 261 of the Atomic Energy Act of 1954*

Project No.	Title	Amount authorized	Current estimated cost Feb. 1, 1960	Overrun or (underrun)
Public Law 86-50:				
60-a-2	Modifications to production and supporting installations	$10,000,000	$10,000,000	0
60-a-2	Prototype installations, gaseous diffusion plants	1,000,000	1,000,000	0
60-a-3	Central computing building, Oak Ridge, Tenn	1,650,000	1,650,000	0
60-a-4	Reactor air filters, Savannah River, S.C	5,000,000	5,000,000	0
60-a-5	Additional raw waterline, Paducah, Ky	810,000	810,000	0
60-a-6	Water plant expansion, 100-K area, Hanford, Wash	5,000,000	5,000,000	0
60-a-7	Modifications to reactor disassembly basins, Savannah River, S.C	1,600,000	1,600,000	0
60-b-1	Cylinder storage area, Paducah, Ky	500,000	500,000	0
60-b-2	Increased cooling water capacity, Savannah River, S.C	5,000,000	5,000,000	0
60-c-1	Weapons production, development and test installations	10,000,000	10,905,000	$905,000
60-c-2 [1]	Special processing plant, phase II, Mound Laboratory, Ohio	3,800,000	95,000	(3,705,000)
60-c-3	Test and environmental installations, Sandia Base, N. Mex	1,000,000	1,000,000	0
60-d-1	Storage site modifications	1,500,000	1,000,000	(500,000)
60-d-2	Materials storage vault, Los Alamos, N. Mex	133,000	133,000	0
60-e-1	Modifications to experimental breeder reactor No. 1 (EBR-1), National Reactor Testing Station, Idaho	1,000,000	1,000,000	0
60-e-2	Portable gas-cooled reactor prototype, National Reactor Testing Station, Idaho	2,500,000	2,500,000	0
60-e-3	Alterations, modifications, and additions to MTR-ETR utility, technical and support installations, National Reactor Testing Station, Idaho	2,000,000	2,000,000	0
60-e-4	Hot cells	2,500,000	2,500,000	0
60-e-5	Chemical processing plant area utility modifications, National Reactor Testing Station, Idaho	750,000	750,000	0
60-e-6	Reactor support installations, Nevada test site	500,000	500,000	0
60-e-7	Nuclear test plant, Army reactor experimental area (AREA), National Reactor Testing Station, Idaho.	5,000,000	5,000,000	0
60-e-8	Modifications and additions for test installation for project Pluto	2,000,000	2,000,000	0
60-e-9	Research and development test plant additions and modifications for project Rover	4,800,000	3,800,000	(1,000,000)
60-e-10	General support installations and utilities expansion, Argonne National Laboratory, Lemont, Ill.	4,300,000	4,300,000	0
60-e-11	Natural circulation test plant, National Reactor Testing Station, Idaho	18,500,000	18,500,000	0
60-e-12	Alterations to shippingport reactor facilities [2]	5,000,000	9,000,000	4,000,000
60-e-13	Experimental organic cooled reactor	6,000,000	6,000,000	0
60-e-14	Experimental low-temperature process heat reactor	4,000,000	4,000,000	0
60-e-15	Power reactor of advanced design capable of utilizing nuclear superheat, to be undertaken either as a cooperative project or conducted solely by the Atomic Energy Commission.	11,000,000	11,000,000	0
60-f-1	Miscellaneous modifications and additions, Argonne National Laboratory, Illinois	1,000,000	1,000,000	0

60-g-1	Project Sherwood plant	1,000,000	1,000,000	0
60-g-2	Accelerator and reactor modifications, Brookhaven National Laboratory, New York	1,950,000	1,950,000	0
60-g-3	Transuranium laboratory, Oak Ridge National Laboratory, Tennessee	1,200,000	1,200,000	0
60-g-4	Physics building, Lawrence Radiation Laboratory, California	2,000,000	2,000,000	0
60-g-5	10 Mev. tandem Van de Graaff accelerator, Oak Ridge, Tenn	2,400,000	2,400,000	0
60-h-1	Installations for support of biomedical research projects in atomic energy	3,000,000	3,000,000	0
60-i-1	High-level radiation development laboratory	1,600,000	1,600,000	0
60-i-2	Radioisotope process development laboratory	1,500,000	1,500,000	0
60-j-1	Radioisotope production area expansion and modifications, Oak Ridge National Laboratory, Tennessee.	300,000	300,000	0
60-k-1	High school additions, Los Alamos, N. Mex	485,000	485,000	0
60-k-2	Real estate development, Los Alamos, N. Mex	240,000	240,000	0
60-k-3	Housing alterations, Los Alamos, N. Mex	1,000,000	1,000,000	0
60-1	General plant	30,882,000	30,732,000	(150)
60-110	Cooperative power reactor demonstration program	25,000,000	25,000,000	0
Public Law 85-590:				
59-a-1	Plant modifications for processing of nonproduction spent fuels, undetermined sites	15,000,000	15,000,000	0
59-a-2	Pilot plant for fabrication of new fuel elements, Fernald, Ohio	335,000	365,000	30,000
59-a-3	Reduction of fire hazards, phase II gaseous diffusion plants, Oak Ridge, Paducah, and Portsmouth.	11,900,000	6,900,000	(5,000,000)
59-a-4	New waste storage installation, Arco, Idaho	3,200,000	3,200,000	0
59-a-5	Production reactor facility for special nuclear materials, convertible type, Hanford, Wash.	145,000,000	145,000,000	0
59-b-1	Weapons production and development plants, locations undetermined	10,000,000	11,021,000	1,021,000
59-b-2	Component fabrication plant, Hanford, Wash	3,500,000	3,500,000	0
59-b-3	Fabrication plant, Oak Ridge, Tenn	12,500,000	9,400,000	(3,100,000)
59-b-4 [1]	Special processing plant, Mound Laboratory, Ohio	2,000,000	114,000	(1,886,000)
59-c-1	Storage site modifications, various locations	1,500,000	500,000	(1,000,000)
59-c-2	Base construction, Eniwetok Proving Ground	2,342,000	2,342,000	0
59-c-3	Base construction, Nevada test site	1,780,000	1,780,000	0
59-c-4	Test area development, Nevada test site	600,000	600,000	0
59-c-5	Phermex installation, Los Alamos, N. Mex	3,550,000	3,550,000	0
59-c-6	Laboratory building, TA-33, Los Alamos, N. Mex	590,000	590,000	0
59-c-7	Test and environmental installations, Sandia Base, N. Mex	1,488,000	1,100,000	(388,000)
59-c-8 [1]	Lineal acceleration tester, Livermore, Calif	390,000	0	
59-c-9	Test assembly building	510,000	510,000	0
59-c-10	High explosive development plant, Livermore, Calif	2,000,000	2,126,000	126,000
59-c-11	Storage and handling building, Livermore, Calif	250,000	250,000	0
59-d-1	Reprocessing pilot plant, Oak Ridge National Laboratory, Tenn	3,500,000	3,500,000	0
59-d-2	Special purpose test installation	2,300,000	2,863,000	563,000
59-d-3	Fast reactor safety testing station Nevada test site	1,367,000	1,367,000	0
59-d-4	Army reactor experimental area (AREA) Arco, Idaho	1,000,000	1,000,000	0
59-d-5	Hot cells	5,000,000	5,000,000	0
59-d-6	Army package power reactor No. 2	3,000,000	3,000,000	0
59-d-7	Modifications to organic moderated reactor experiment (OMRE), experimental boiling water reactor (EBWR), and boiling reactor experiment (BORAX).	6,300,000	5,300,000	(1,000,000)
59-d-8	Heavy water component test reactor	8,000,000	9,300,000	1,300,000
59-d-9	Fuels technology centers addition, Argonne National Laboratory, Illinois	5,000,000	5,000,000	0
59-d-10	Flexible experimental prototype gas-cooled reactor	30,000,000	30,000,000	0
59-d-11	Project Sherwood plant	2,000,000	1,970,000	(30,000)
59-d-12	Design and development, heavy water moderated power reactor	4,500,000	[2] 1,459,000	[3](3,041,000)

See footnotes at end of table,

TABLE 1A.—*Current estimated costs of active authorized projects compared with estimated costs shown in authorizations enacted pursuant to sec. 261 of the Atomic Energy Act of 1954*—Continued

Project No.	Title	Amount authorized	Current estimated cost Feb. 1, 1960	Overrun or (underrun)
Public Law 85-590—Con.				
59-d-13	Design and engineering studies of 2 large-scale power reactors and 1 intermediate-size prototype-power reactor.	$6,000,000	$2,266,000	($3,734,000)
59-d-14	Design and engineering study of a power reactor of advanced design capable of utilizing nuclear superheat, such study to be undertaken either as a cooperative project or conducted solely by the Atomic Energy Commission.	750,000	300,000	(450,000)
59-d-15	Metals and ceramics research building, Oak Ridge National Laboratory, Tennessee	6,500,000	6,500,000	0
59-d-16	Metals process development plant, Ames, Iowa	1,900,000	1,900,000	0
59-e-1	Accelerator improvements, University of California, Radiation Laboratory, California.	1,300,000	1,325,000	25,000
59-e-2	CP-5 reactor improvements, Argonne National Laboratory, Illinois	500,000	487,000	(13,000)
59-e-3	2 accelerators, beam analyzing system and magnet, Pennsylvania State University, Pennsylvania.	950,000	950,000	0
59-e-4	Cyclotron, University of California Radiation Laboratory	5,000,000	4,600,000	(400,000)
59-e-5	Central research laboratory addition, Oak Ridge National Laboratory	3,500,000	3,057,000	(443,000)
59-e-6	Chemistry building addition, University of California Radiation Laboratory	2,000,000	2,000,000	0
59-e-7	Chemistry hot laboratory, Argonne National Laboratory	4,400,000	4,400,000	0
59-e-8	Expansion of stable isotopes production capacity, Oak Ridge National Laboratory	900,000	900,000	0
59-e-9	High energy physics building, Columbia University	500,000	500,000	0
59-e-10	Particle accelerator program addition, Harvard-MIT accelerator	1,300,000	1,430,000	130,000
59-e-11	High flux research reactor, Brookhaven National Laboratory	10,000,000	10,000,000	0
59-e-12	Research and engineering reactor, Argonne National Laboratory, design and engineering.	1,000,000	1,000,000	0
59-e-13	Van de Graaff accelerator, Argonne National Laboratory	2,500,000	2,500,000	0
59-e-14	Cyclotron, Oak Ridge National Laboratory	3,000,000	3,725,000	725,000
59-e-15	Research reactor, Ames Laboratory	3,800,000	3,765,000	(35,000)
59-f-1	Installations for support of research dealing with radioactive fallout and related radiation hazards.	2,000,000	2,005,000	5,000
59-g-1	Additional plant for the Regional Nuclear Training Center, Puerto Rico	500,000	600,000	100,000
59-g-2	International Atomic Energy Agency research reactors and laboratory equipment grant	2,000,000	900,000	(1,100,000)
59-g-3 [1]	Gamma process development irradiator	1,600,000	0	----------
59-h-1	School storage building, Hanford, Wash	75,000	75,000	0
59-i	General plant	25,602,000	25,158,000	(444,000)
Public Law 85-162:				
58-b-2	Mechanical production line, Hanford, Wash	1,500,000	1,870,000	370,000
58-b-4	Improvements to production and supporting installations, Hanford, Wash., and Savannah River, S.C.	10,000,000	12,479,000	2,479,000
58-b-5 [1]	Additions to scrap plants, various sites	1,500,000	0	----------
58-b-6	Additions to gaseous diffusion plants	6,600,000	1,020,000	(5,580,000)
58-b-7	Reduction in fire hazards, gaseous diffusion plants, Oak Ridge, Paducah, and Portsmouth.	12,000,000	12,300,000	300,000
58-c-1	Weapons production and development plant	10,000,000	9,403,000	(597,000)

58-c-2 [1]	Weapons special component plant	6,000,000	0	
58-d-1	Manufacturing plant expansion, Albuquerque, N. Mex	3,325,000	2,950,000	(375,000)
58-d-2	Storage site modifications	2,000,000	1,539,000	(461,000)
58-d-3	High explosive development plant, Livermore, Calif	2,100,000	2,420,000	320,000
58-d-4	Engineering and laboratory building, Los Alamos, N. Mex	1,013,000	1,006,000	(7,000)
58-d-5	Ventilation system replacements, Los Alamos, N. Mex	618,000	450,000	(168,000)
58-d-6	Reclamation foundry, shop, and warehouse, Sandia Base, N. Mex	308,000	338,000	30,000
58-d-7	Reactor, area III, Sandia Base, N. Mex	2,900,000	3,185,000	285,000
58-d-8	Base construction, Nevada test site	350,000	370,000	20,000
58-d-9	Base construction, Eniwetok Proving Ground	7,917,000	7,917,000	0
58-e-1	Power reactor development acceleration project	11,500,000	10,100,000	(1,400,000
58-e-3	Fuels technology center, Argonne National Laboratory, Illinois	10,000,000	12,000,000	2,000,000
58-e-4	Modifications and additions, aircraft nuclear propulsion ground test plant, area No. 1, National Reactor Testing Station, Idaho.	8,000,000	8,000,000	0
58-e-5	Test installations for classified project	9,000,000	10,477,000	1,477,000
58-e-6	Project sherwood plant	10,000,000	10,926,000	926,000
58-e-7	Waste calcination system, National Reactor Testing Station, Idaho	6,000,000	6,000,000	0
58-e-8	Hot cells	3,500,000	2,483,000	(1,017,000)
58-e-9	High temperature test installation, Bettis plant, Pennsylvania	3,000,000	3,000,000	0
58-e-10	Destroyer reactor development plant	750,000	750,000	0
58-e-11	Sodium reactor experiment (SRE) modification, Santa Susana, Calif	4,700,000	4,700,000	0
58-e-15	Plutonium recycle experimental reactor designed for the production of 15,000 electrical kilowatt equivalent.	15,000,000	14,000,000	(1,000,000)
58-e-16	Destroyer reactor plant, West Milton, N.Y	35,000,000	35,000,000	0
58-f-1	Waste storage tanks, National Reactor Testing Station, Idaho	3,700,000	2,205,000	(1,495,000)
58-f-2	Hot pilot plant	2,000,000	2,000,000	0
58-f-3	Land acquisition, National Reactor Testing Station, Idaho	1,000,000	1,000,000	0
58-g-1	Accelerator improvements, University of California Radiation Laboratory, California	875,000	875,000	0
58-h-1	Reactor improvements, Argonne National Laboratory, Illinois	380,000	393,000	13,000
58-i-1	Mammalian radiation injury and recovery area, Oak Ridge National Laboratory, Tennessee.	475,000	522,000	47,000
58-j-1	Nuclear training project, Regional Nuclear Training Center, Puerto Rico	2,500,000	3,050,000	550,000
58-k-2	Housing modifications, Los Alamos, N. Mex	1,000,000	1,000,000	0
58-k-3	Additional water well, Los Alamos, N. Mex	138,000	138,000	0
58-1	General plant projects	26,016,000	24,889,000	(1,127,000)
58-111	Cooperative power reactor demonstration program	49,971,000	49,971,000	
58-104-1	Rehabilitation of steam plant, Oak Ridge		1,234,000	
Public Law 506, 84th Cong., 2d sess.:				
57-a-2	Improvements to reactor instrumentation, Hanford, Wash	8,000,000	3,350,000	(4,650,000)
57-a-3	Improved high level waste handling system, Savannah River	5,000,000	3,000,000	(2,000,000)
57-a-4	Reactor facility safety improvements, Hanford	5,000,000	558,000	(4,442,000)
57-a-5	Additional waste disposal system, Hanford	5,000,000	4,020,000	(980,000)
57-a-6	Charging and discharging system, Hanford	3,450,000	3,700,000	250,000
57-a-7 [1]	Modifications to existing production facilities for increased efficiency and safety, Hanford.	3,000,000	0	
57-b-1	Area 5 expansion	20,900,000	20,725,000	(175,000)
57-b-2	Weapons assembly plants	15,000,000	7,850,000	(7,150,000)
57-b-3	Weapons production and development plant	15,000,000	17,586,000	2,586,000
57-b-4	Weapons development and engineering facilities, Livermore	10,000,000	11,860,000	1,860,000
57-b-5	Storage site modifications	2,000,000	2,113,000	113,000
57-c-1	Aircraft nuclear propulsion ground test plant, area No. 2, Idaho	55,000,000	878,000	(54,122,000)

See footnotes at end of table.

TABLE 1A.—*Current estimated costs of active authorized projects compared with estimated costs shown in authorizations enacted pursuant to sec. 261 of the Atomic Energy Act of 1954*—Continued

Project No.	Title	Amount authorized	Current estimated cost Feb. 1, 1960	Overrun or (underrun)
Public Law 506, 84th Cong., 2d sess.—Continued				
57-c-2	Research and developmental test plant	$25,000,000	$29,740,000	$4,740,000
57-c-3	Modifications and expansion of aircraft nuclear propulsion ground test facilities, area No. 1, Idaho.	15,000,000	15,000,000	0
57-c-4	Small submarine reactor test facility	10,000,000	13,500,000	3,500,000
57-c-5	Expended core handling and service plant, National Reactor Testing Station	4,750,000	4,750,000	0
57-c-7	Project Sherwood plant	2,000,000	926,000	(1,074,000)
57-c-8	Argonne low-power reactor facility	1,225,000	1,904,000	679,000
57-c-9	Materials testing reactor hot-cell extension, National Reactor Testing Station	310,000	310,000	0
57-d-1	Zero gradient synchrotron, Argonne National Laboratory, Illinois	27,000,000	[4] 42,000,000	[4] 15,000,000
57-d-4	Conversion of accelerator design building, University of California Radiation Laboratory.	300,000	300,000	0
57-f-1	Metallurgy Laboratory, Livermore, Calif	2,270,000	2,270,000	0
57-f-3	High-explosive and weaponizing plant, Livermore	1,100,000	1,136,000	36,000
57-g-1	Addition to electrical power system, National Reactor Testing Station	3,800,000	3,800,000	0
57-g-2	Chemistry cave for radioactive materials, Argonne National Laboratory	800,000	818,000	18,000
57-h-1	Permanent research buildings, Oak Ridge National Laboratory	5,780,000	5,555,000	(225,000)
57-h-2	Physics building, Brookhaven National Laboratory	3,040,000	3,300,000	260,000
57-h-3	Engineering building, Brookhaven National Laboratory	1,879,000	1,879,000	0
57-h-4	Engineering service building, University of California Radiation Laboratory	1,080,000	1,188,000	108,000
57-h-5	Cosmotron target area, Brookhaven National Laboratory	3,550,000	3,550,000	0
57-j-1	Real-estate development program, Los Alamos, N. Mex	359,000	393,000	34,000
57-n	General plant projects	21,000,000	19,514,000	(1,486,000)
Public Law 141, 84th Cong., 1st sess.:				
56-b-2	Fast power breeder pilot facility (EBR-II)	29,100,000	29,100,000	0
56-b-3	Surface ship reactor facility	25,000,000	35,000,000	10,000,000
56-b-4	Submarine advanced reactor facility	23,140,000	23,140,000	0
56-b-5	Submarine advanced reactor development facilities, Schenectady, N.Y	3,100,000	3,100,000	0
56-b-6	Aircraft nuclear propulsion program plant and test area, Arco, Idaho	13,000,000	12,500,000	(500,000)
56-c-1	Particle accelerator program	19,406,000	21,406,000	2,000,000
56-d-2	Reactor facilities modifications, Hanford, Wash	11,900,000	12,900,000	1,000,000
56-d-6	Barrier plant addition, Oak Ridge, Tenn	2,200,000	1,748,000	(452,000)
56-f-3	New Sigma Laboratory, Los Alamos, N. Mex	5,100,000	5,420,000	320,000
56-g-6	Research reactor, Philippine Government	500,000	500,000	0
56-i-1	Medical research plant and facility, Brookhaven National Laboratory	6,040,000	6,400,000	360,000
56-j-2	New community hospital, Oak Ridge, Tenn	2,900,000	2,900,000	0
56-k-1	Offsite access roads	4,165,000	3,900,000	(265,000)
56-l-1	General plant projects	17,960,000	16,744,000	(1,216,000)

[1] Proposed for rescission in fiscal year 1961 authorization bill.

[2] Project amendment being proposed in fiscal year 1961 authorization bill.

[3] This project was first authorized in Public Law 85-590 at a cost of $2,500,000 to provide for a design and engineering report on a heavy water reactor which would be operable using natural uranium or slightly enriched uranium. As required by the act, a report was submitted on this study to the JCAE and subsequently work under this design study was terminated at a final estimated cost of $1,450,000.

[4] Project amendment being proposed in fiscal year 1961 authorization bill. This increase will provide for significant additions to the experimental facilities and related power supplies, cooling systems and machine controls, and improvements to the operating capabilities of the machine. These additional facilities need to be incorporated in the initial construction in order not to require a prolonged shutdown of the machine at a later date to incorporate these features.

[3] This project was first authorized in Public Law 85-500 at a cost of $2,500,000 to provide for a design and engineering report on a heavy water reactor which would be operable using natural uranium or slightly enriched uranium. As required by the act, a report was submitted on this study to the JCAE and subsequently work under his design study was terminated at a final estimated cost of $1,459,000.

related power supplies, cooling systems and machine controls, and improvements to the operating capabilities of the machine. These additional facilities need to be incorporated in the initial construction in order not to require a prolonged shutdown of the machine at a later date to incorporate these features.

TABLE 1B.—*Current estimated costs of active projects undertaken under authority available to the AEC prior to the enactment of the Atomic Energy Act of 1954, compared with estimated costs shown in a budget justification submitted to the Congress for fiscal year 1955*

Project No.	Title	Estimated in fiscal year 1955 budget to Congress	Current estimated cost (Feb. 1, 1960)	Overrun or (underrun)
Special nuclear materials:				
223-4022	Pile modification facilities	$27,472,000	$28,519,000	$1,047,000
223-1073	Production facility, Hanford	64,490,000	64,200,000	(290,000)
223-9040	Land acquisition, Wahluke slope and other leased land	[1] 1,244,610	2,754,000	1,509,390
223	Savannah River projects	1,500,000,000	1,336,909,000	(163,091,000)
Weapons:				
337-5001	Research facilities	4,100,000	5,535,000	1,435,000
331-3002	Demolition of vacated structures	750,000	430,000	(320,000)
330-4001 and 1007	Weapons construction projects	132,628,013	119,958,000	(12,670,013)
Reactor development:				
442-5003	Plutonium fabrication facility	[2] 3,000,000	3,991,000	991,000
444-4001	Pressurized water reactor	40,000,000	50,000,000	10,000,000
441-5011	Increased chemical processing plant capacity	10,654,000	11,180,000	526,000
443-5003	Army package power reactor No. 1	2,100,000	1,554,000	(546,000)
445-4002	Reactor room compartment, SIR, mark B	18,000,000	18,365,000	365,000
424-4025	Engineering test equipment	835,000	835,000	0
Physical research: 562-4019	Alternating gradient synchrotron	20,000,000	31,000,000	11,000,000

[1] Estimate in fiscal year 1954 budget to Congress.

[2] Estimate in fiscal year 1956 budget to Congress.

TABLE 1C.—*Other authorized projects*

Title	Authorized	Current cost estimate	Overrun or (underrun)
Public Law 221, 84th Cong., 1st sess.: Projects relating to the disposal of community facilities:			
Oak Ridge	$518,000	$518,000	0
Hanford (as amended by Public Law 802, 84th Cong., 2d sess.)	2,215,000	2,141,000	[1] ($74,000)
Public Law 31, 84th Cong., 1st sess.: AEC headquarters building (as amended by Public Law 85-107)	13,300,000	13,300,000	0
Public Law 848, 84th Cong., 2d sess.: Nuclear-powered merchant ship	[2]	26,250,000	

[1] Project complete.

[2] None stated.

TABLE 2A.—*Active authorized projects on which revised cost estimates have exceeded the authorization limitations after the project has been started*

Project No.	Title	Amount authorized	Allowable cost	Date of start of project	Cost estimate at start of project	Current estimate (Feb. 1, 1960)	Overrun
Public Law 84-141:							
55-c-3	Surface ship reactor facility	$25,000,000	$31,250,000	Apr. 3, 1956	$29,800,000	$35,000,000	$3,750,000
Public Law 84-506:							
57-c-4	Small submarine reactor test facility	10,000,000	12,500,000	Feb. 25, 1957	10,000,000	13,500,000	1,000,000
57-c-8	Argonne low power reactor facility	1,225,000	1,531,250	Apr. 18, 1957	1,300,000	1,904,000	372,750
Public Law 85-162:							
58-d-3	High explosive development plant, Livermore, Calif.	2,100,000	2,310,000	June 30, 1958	2,100,000	2,420,000	110,000

TABLE 2B.—*Active projects undertaken under authority available to the AEC prior to the enactment of the Atomic Energy Act of 1954 on which revised cost estimates have exceeded the authorization limitations after the project has been started*

Project No.	Title	Amount included in 1955 estimates to Congress	Estimated in budget to Congress plus additional allowance	Current estimate		Overrun
				Date	Amount	
223-9040	Land acquisition, Wahluke slope and other leased land	[1] $1,244,610	$1,680,223	Feb. 1, 1960	$2,754,000	$1,073,777
562-4019	Alternating gradient synchrotron	20,000,000	27,000,000	do	31,000,000	4,000,000

[1] Estimate in fiscal year 1954 budget to Congress.

TABLE 3A.—*Projects authorized pursuant to sec. 261 of the Atomic Energy Act of 1954 which have been completed*

Project No.	Title	Amount authorized	Date of start of project	Cost estimate at start of project	Final cost	Overrun or (underrun)
Authorized by Public Law 84-141:						
56-a-1	Production or development plants or facilities	$20,000,000	Oct. 21, 1955	$21,741,000	$28,331,000	$6,590,000
56-b-7	Aircraft reactor test plant	1,437,000	Aug. 23, 1955	1,437,000	1,070,000	(367,000)
56-b-8	Modifications and expansions to ANP ground test plant, Idaho	1,000,000	Sept. 6, 1955	1,000,000	1,090,000	90,000
56-b-9	Special reactor facilities construction program	2,000,000	Nov. 11, 1955		797,000	(1,203,000)
56-b-10	Reactor core test facility, Arco, Idaho	600,000	Oct. 15, 1955	600,000	430,000	(170,000)
56-d-4	Modifications to separating and processing facilities, Hanford, Wash	2,550,000	Feb. 13, 1956	2,550,000	2,289,000	(261,000)
56-d-7	New barrier development plant, Oak Ridge, Tenn	404,000	Feb. 1, 1956	439,000	490,000	86,000
56-e-1	Expansion and modification of ore processing plant, Monticello, Utah	1,550,000	Nov. 10, 1955	800,000	825,000	(725,000)
56-e-2	Storage sites for vanadium bearing tailings	500,000			22,000	(478,000)
56-f-4	Detonator production plant	3,750,000	Nov. 21, 1955	1,900,000	1,896,000	(1,854,000)
56-f-5	Base construction, Pacific proving ground	1,568,000	Oct. 1, 1955	1,568,000	1,569,000	1,000
56-f-6	Rocky Flats, Colo., plant and facilities	1,330,000	Aug. 22, 1955	1,330,000	862,000	(468,000)
56-f-7	Base construction, Nevada test site	927,000	Apr. 6, 1956	927,000	807,000	(120,000)
56-f-8	Addition to technical laboratory shop building, Los Alamos, N. Mex	735,000	May 3, 1956	655,000	578,000	(157,000)
56-g-1	Engineering test reactor facility	14,350,000	Oct. 13, 1955	15,000,000	15,223,000	873,000
56-g-4	Reactor engineering building addition, Argonne National Laboratory	295,000	Oct. 17, 1955	324,500	324,000	29,000
56-g-5	High level chemical development facility, Oak Ridge National Laboratory.	280,000	Aug. 27, 1956	300,000	267,000	(13,000)
56-h-1	Conversion of existing building to development plant, Oak Ridge National Laboratory.	1,150,000	Aug. 22, 1956	150,000	149,000	(1,001,000)
56-h-2	Fabrication plant for development equipment, Oak Ridge National Laboratory.	440,000	Apr. 16, 1956	440,000	474,000	34,000
56-j-1	Additional housing units, Monticello, Utah	250,000	Oct. 4, 1956	170,000	171,000	(79,000)
56-j-3	Water and sewer replacements and improvements, Richland, Wash	160,000	Oct. 30, 1956	133,000	119,000	(41,000)
56-j-4	Housing program (group 18) Los Alamos, N. Mex	3,500,000	May 22, 1956	3,823,000	3,744,000	244,000
56-104-1	Pressure vessel, Beta 2 facility, Oak Ridge, Tenn		Jan. 10, 1956	750,000	653,000	

See footnotes at end of table.

TABLE 3A.—*Projects authorized pursuant to sec. 261 of the Atomic Energy Act of 1954 which have been completed*—Continued

Project No.	Title	Amount authorized	Date of start of project	Cost estimate at start of project	Final cost	Overrun or (underrun)
Authorized by Public Law 84-506:						
57-a-13	Renovation of serviceplant, Oak Ridge, Tenn	$450,000	Dec. 9, 1957	$304,000	$267,000	($183,000)
57-d-2	Bevatron research plant, University of California Radiation Laboratory	1,084,000	Apr. 1, 1957	1,200,000	1,098,000	14,000
57-e-1	Analytical laboratory addition, Grand Junction, Colo	362,000	Oct. 18, 1956	369,000	322,000	(40,000)
57-f-2	Base construction, Pacific proving ground	1,569,000	Jan. 1, 1957	1,675,000	1,716,000	147,000
57-f-4	Installation of 115 kilovolt tie line, Los Alamos, N. Mex	1,000,000	July 5, 1957	900,000	811,000	(189,000)
57-f-5	Base construction, Nevada test site	543,000	Dec. 24, 1956	597,000	597,000	54,000
57-f-7	Warehouse: Sandia	308,000	Mar. 28, 1957	338,000	258,000	(50,000)
57-f-9	Programing building, Livermore, Calif	180,000	Mar. 18, 1957	180,000	180,000	0
57-g-3	Transient housing, Argonne National Laboratory	533,000	June 14, 1957	533,000	533,000	0
57-g-4	Materials testing reactor maintenance shop, National Reactor Testing Station.	235,000	Jan. 31, 1957	258,000	258,000	23,000
57-h-6	18-inch cyclotron building, Brookhaven National Laboratory	300,000	Dec. 1, 1957	300,000	313,000	13,000
57-h-7	Addition to heavy ion accelerator building, University of California Radiation Laboratory.	200,000 400,000	Mar. 18, 1957 Mar. 5, 1958	200,000 418,000	198,000 422,000	(2,000) 22,000
57-i-1	Reclamation plant and hot laundry, Brookhaven National Laboratory					
57-j-2	Elementary school classrooms, Los Alamos, N. Mex	915,000	Nov. 21, 1956	195,000	194,000	(1,000)
57-k-1	Conversion of barracks for Albuquerque operations office headquarters, Sandia Base, Albuquerque, N. Mex.	600,000	June 10, 1957	660,000	662,000	62,000
57-k-2	Renovation of building for technical information services Oak Ridge, Tenn.	517,000	Oct. 29, 1956	568,000	560,000	43,000
57-l-1	Offsite access roads	2,873,000			2,073,000	(800,000)
57-m-1	Purchase of Bettis Field property	400,000			400,000	
57-104-1	Emergency plant replacement of fire damage, Paducah				494,000	
Authorized by Public Law 85-162:						
58-b-8	Production reactor for special nuclear materials; development, design, and engineering only.	3,000,000			(1)	
58-e-14	Natural uranium, graphite moderated, gas-cooled, power reactor prototype; development, design and engineering only.	3,000,000			(1)	
58-k-1	Schools, Los Alamos, N. Mex	965,000	Apr. 1, 1958	1,061,000	1,060,000	96,000

[1] Funded from operating expenses appropriation.

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TABLE 3B.—*Projects undertaken under authority available to the Atomic Energy Commission prior to the enactment of the Atomic Energy Act of 1954 to be completed within the current fiscal year*

Project No.	Title	Estimated in fiscal year 1955 budget to Congress	Estimated final cost	Overrun or (underrun)
223–1073	Production facility, Hanford	$64,490,000	$64,200,000	($290,000)
331–3002	Demolition of vacated structures	750,000	430,000	(320,000)
330–4001–1007	Weapons construction projects	132,628,013	119,958,000	(12,670,013)
442–5003	Plutonium faricati n facility	[1] 3,000,000	3,991,000	991,000
441–5011	Increased chemical processing plant capacity	10,654,000	11,180,000	526,000
443–5003	Army package power reactor No. 1	2,100,000	1,554,000	(546,000)
424–4025	Engineering test equipment	835,000	835,000	0

[1] Estimate in fiscal year 1956 budget to Congress.

TABLE 4.—*Current unliquidated obligations on projedts for which authorization was rescinded by Public Laws 8–62, 85–590, and 86–50*

Project No.	Title	Amount authorized	Unliquidated Feb. 1, 1960
Authorized by Public Law 84-141:			
56-b-1	Power reactor development acceleration project	$25,000,000	0
56-d-1	Metallex pilot facility, Oak Ridge National Laboratory	1,000,000	0
56-d-3	Special reactor facilities equipment, Hanford, Wash	5,600,000	0
56-d-5	Conversion of pilot plant and facility to production plant and facility, Fernald, Ohio	600,000	0
56-d-8	Expansion of metal recovery facility, Oak Ridge National Laboratory	370,000	0
56-f-1	Art construction project, fiscal year 1956 increment	17,873,000	0
56-f-2	Expansion of weapons material fabrication plant and facility	15,000,000	0
56-g-2	Reactor training school, Argonne National Laboratory	712,000	0
56-g-3	Chemistry cave for radioactive materials, Argonne National Laboratory	448,000	0
56-g-7	Research reactors for the development of peacetime uses of atomic energy under agreements for cooperation	5,000,000	0
Authorized by Public Law 84-506:			
57-a-1	Additional feed materials plant	22,200,000	0
57-a-8	Chemical processing facility, St. Louis, Mo	1,600,000	0
57-a-9	Barrier plant automation, Oak Ridge, Tenn	1,400,000	0
57-a-10	Reactor temperature test installation, Hanford, Wash	900,000	0
57-a-11	Improvements to reactor cooling water effluent system, Hanford, Wash	550,000	0
57-a-12	Fuel element heat-treating plant, Fernald, Ohio	500,000	0
57-c-6	Food irradiation facility	3,000,000	0
57-c-10	Amended reactor development project	15,000,000	0
57-d-3	48-inch heavy particle cyclotron, Oak Ridge National Laboratory	459,000	0
57-f-6	Manufacturing support plant, Kansas City, Mo	444,000	0
57-f-8	Mechanical shop additions, Livermore, Calif	300,000	0
Authorized by Public Law 85-162:			
58-b-1	Fabrication plant	5,000,000	0
58-b-3	Metal treatment plant, Fernald, Ohio	850,000	0
58-e-12	Liquid metal fuel reactor experiment	17,500,000	0
58-e-13	Argonne boiling reactor (ARBOR), National Reactor Testing Station, Idaho	8,500,000	0

TABLE 5.—*Projects authorized pursuant to sec. 261 of the Atomic Energy Act of 1954 which are being abandoned, substituted for, or superseded by revised authorizations*

Project No.	Title	Estimate in Authorization Act	Explanation
Public Law 86-50:			
60-c-2	Special processing plant, phase II, Mound Laboratory, Ohio.	$3,800,000	It was initially planned to install a special processing capability at Mound Laboratory. Congress authorized $5,800,000 in 2 increments for the Mound special processing plant. However, due to program changes this plant will not be needed. It is planned to meet the presently projected special processing workload by adding equipment to an existing plant. Such equipment will be funded from the operating expense appropriation.
Public Law 85-590:			
59-b-4	Special processing plant, Mound Laboratory, Ohio.	2,000,000	
59-c-8	Lineal acceleration tester, Livermore, Calif.	390,000	It was originally thought that this facility would be required at Livermore. However, it has since proved to be more advantageous to do all the work in the Albuquerque area, where other related work is performed.
59-g-3	Gamma process development irradiator	1,600,000	Due to the early state of development of technology of massive radiation use, industry is not ready to utilize this type facility on a full-time basis, nor is industry willing to make a financial contribution to its construction. (Recission of this project was proposed by letter of Apr. 29, 1959, from the General Manager to Mr. Holifield.)
Public Law 85-162:			
58-b-5	Additions to scrap plants, various sites	1,500,000	Present program planning indicates no requirement for this project.
58-c-2	Weapons special component plant	6,000,000	This project was to provide an additional weapons special component plant; however, changes in requirements permit the rescission of this project.
Public Law 84-506:			
57-a-7	Modifications to existing production facilities for increased efficiency and safety Hanford, Wash.	3,000,000	Rescission is requested as obtainment of the original project objectives has been achieved by less costly means. Process operating improvements, modification and use of silica gel and ion exchange prototype facilities, and plant flow changes have provided the desired improvements.

NOTE.—Only those projects proposed for rescission in the 1961 authorization bill are included in this table. Projects already rescinded are shown on table 6B.

PROJECTS NOT STARTED

TABLE 6A.—*Projects which have been authorized but for which funds are not currently available*

[Thousands]

Project No.	Title	Authorized amount	Explanation
Authorized by Public Law 85-590:			
59-d-3	Fast reactor safety testing station, Nevada test site	$1,367	Deferred because of programmatic changes.
59-e-3	2 accelerators, beam analyzing system and magnet, Pennsylvania State University, Pennsylvania.	950	Revised Pennsylvania State University proposal is currently being reviewed.
59-e-12	Research and engineering reactor, Argonne National Laboratory, design and engineering.	1,000	Deferred until after fiscal year 1961.

PROJECTS NOT STARTED

TABLE 6B.—*Projects for which authorization has been rescinded or is presently being offered for rescission*

Project No.	Title	Amount authorized	Remarks [1]
Proposed for rescission in fiscal year 1961 authorization bill:			
60-e-2	Special processing plant, phase II, Mound Laboratory, Ohio.	$3,800,000	It was initially planned to install a special processing capability at Mound Laboratory. Congress authorized $5,800,000 in 2 increments for the Mound special processing plant. However, due to program changes this plant will not be needed. It is planned to meet the presently projected special processing workload by adding equipment to an existing plant. Such equipment will be funded from the operating expense appropriation.
59-b-4	Special processing plant, Mound Laboratory, Ohio	2,000,000	
59-c-8	Lineal acceleration tester, Livermore, Calif	390,000	It was originally thought that this facility would be required at Livermore. However, it has since proved to be more advantageous to do all the work in the Albuquerque area, where other related work is performed.
59-g-3	Gamma process development irradiator	1,600,000	Due to the early state of development of technology of massive radiation use, industry is not ready to utilize this type facility on a full time basis, nor is industry willing to make a financial contribution to its construction. (Rescission of this project was proposed by letter of Apr. 29, 1959, from the general manager to Mr. Holifield.)
58-b-5	Additions to scrap plants, various sites	1,500,000	Present program planning indicates no requirement for this project.

58-c-2	Weapons special component plant	6,000,000	This project was to provide an additional weapons special component plant; however, changes in requirements permit the rescission of this project.
57-a-7	Modifications to existing production facilities for increased efficiency and safety, Hanford, Wash.	3,000,000	Rescission is requested as obtainment of the original project objectives has been achieved by less costly means. Process operating improvements, modification and use of silica gel and ion exchange prototype facilities, and plant flow changes have provided the desired improvements.
Rescinded in fiscal year 1960 authorization act, Public Law 86-50:			
58-e-12	Liquid metal fuel reactor experiment (LMFRE)	17,500,000	Present technology not sufficiently advanced to warrant proceeding with design of the proposed plant.
57-d-3	48-inch heavy particle cyclotron, Oak Ridge National Laboratory.	459,000	Authorization of project 59-e-14, cyclotron, Oak Ridge National Laboratory eliminated the requirement for this project.
Rescinded in fiscal year 1959 authorization act, Public Law 85-590:			
58-b-1	Fabrication plant	5,000,000	Present technology not sufficiently advanced to warrant proceeding with design of the proposed plant.
58-b-3	Metal treatment plant, Fernald, Ohio	850,000	Economics attributable to the proposed plant no longer attractive due to improved processes in FMPC.
58-e-13	Argonne boiling reactor (ARBOR), National Reactor Testing Station, Idaho.	8,500,000	In view of other projects underway in the boiling water reactor field, the utility of this reactor as a test facility was greatly reduced.
57-e-6	Food irradiation facility	3,000,000	This project was abandoned since the Department of Defense favors an irradiated-cobalt facility which will be funded by that Department. Reference is made to the letter of Mar. 18, 1958, from the Chairman, AEC, to the Chairman, JCAE, on this project.
Rescinded in fiscal year 1958 authorization act, Public Law 85-162:			
57-a-1	Additional feed materials, plant	22,200,000	Requirements met by plant constructed by private industry.
57-a-8	Chemical processing facility, St. Louis, Mo	1,600,000	Change in materials requirements.
57-a-9	Barrier plant automation, Oak Ridge, Tenn	1,400,000	Economics of further automation no longer attractive.
57-a-10	Reactor temperature test installation, Hanford, Wash.	900,000	Due to technical delays, work proceeding at slow rate under operating expenses.
57-a-11	Improvements to reactor cooling water effluent system, Hanford, Wash.	550,000	Deferred indefinitely because of technical problems.
57-a-12	Fuel element heat-treating plant, Fernald, Ohio	500,000	Technology found not to be advantageous.
57-e-10	Amended reactor development project	15,000,000	The individual subprojects planned were authorized separately in fiscal year 1958 authorization act as follows: Project 58-e-12: Liquid metal fuel reactor experiment (LMFRE), $17,500,000; Project 58-e-13: Argonne boiling reactor (ARBOR), National Reactor Testing Station, Idaho, $8,500,000; and Sec. 111: Cooperative power reactor demonstration program, $129,915,000.
57-f-6	Manufacturing support plant, Kansas City, Mo	444,000	Constructed as part of plant additions and revised storage under 57-b-3.
57-f-8	Mechanical shop additions, Livermore, Calif	300,000	Revised requirements dictated a larger facility accomplished under 57-b-3.
56-b-1	Power reactor development acceleration project	25,000,000	See remarks for project 57-e-10.

See footnotes at end of table.

TABLE 6B.—*Projects for which authorization has been rescinded or is presently being offered for rescission*—Continued

Project No.	Title	Authorized amount	Remarks[1]
Rescinded in fiscal year 1958 authorization act, Public Law 85-162:			
56-d-1	Metallex pilot facility, Oak Ridge National Laboratory.	$1,000,000	Change in production program eliminated requirement for this facility.
56-d-3	Special reactor facilities equipment, Hanford, Wash.	5,600,000	Dropped because technical problems indicated higher costs.
56-d-5	Conversion of pilot plant and facility to production plant and facility, Fernald, Ohio.	600,000	Change in program eliminated requirement for this project.
56-d-8	Expansion of metal recovery facility, Oak Ridge National Laboratory.	370,000	Change in program eliminated requirement for this project.
56-f-1	Art construction project, fiscal year 1956 increment.	17,873,000	Change in requirements.
56-f-2	Expansion of weapons material fabrication plant and facility.	15,000,000	Do.
56-g-2	Reactor training school, Argonne National Laboratory.	712,000	Facility requirements were met by utilizing existing facilities with some minor modifications.
56-g-3	Chemistry cave for radioactive materials, Argonne National Laboratory.	448,000	This project was superseded by project 57-g-2 "Chemistry cave for radioactive materials, Argonne National Laboratory, $800,000," in fiscal year 1957 authorization act.
56-g-7	Research reactors for the development of peacetime uses of atomic energy under agreements for cooperation.	5,000,000	This project was abandoned since it was subsequently decided to provide funds under the mutual security program for these reactors.

[1] Remarks shown were current at the time rescission was prepared.

PROJECTS NOT STARTED

TABLE 6C.—*Projects which have been authorized and for which money is available*

[Thousands]

Project No.	Title	Amount authorized	Explanation
Authorized by Public Law 85-50:			
60-a-2	Prototype installations, gaseous diffusion plants	$1,000	Under study.
60-a-4	Reactor air filters, Savannah River, S.C.	5,000	Preliminary engineering underway.
60-a-6	Water plant expansion, 100-K area, Hanford, Wash.	5,000	Do.
60-a-7	Modifications to reactor disassembly basins, Savannah River, S.C.	1,600	Design to start in 2d quarter of calendar 1960.

	Modifications to reactor disassembly basins, Savannah River, S.C.	5,000	Do.
		1,600	Design to start in 2d quarter of calendar 1960.
60-b-1	Cylinder storage area, Paducah, Ky	500	Project to start in 2d quarter of calendar 1960.
60-c-3	Test and environmental installations, Sandia Base, N. Mex.	1,000	Design to start February 1960; construction scheduled to start May 1960.
60-d-2	Materials storage vault, Los Alamos, N. Mex	133	Engineering completed; construction scheduled to start March 1960.
60-e-1	Modifications to experimental breeder reactor No. 1 (EBR-1), National Reactor Testing Station, Idaho.	1,000	Conceptual study underway.
60-e-8	Modifications and additions for test installation for project Pluto.	2,000	Design underway.
60-e-11	Natural circulation test plant, National Reactor Testing Station, Idaho.	18,500	Conceptual design underway.
60-e-12	Alterations to Shippingport reactor facilities	5,000	No satisfactory negotiations have been made with Duquesne as of this time for providing additional generating capacity to take off the additional heat to be generated by core 2. The fiscal year 1961 authorization bill provides $4,000,000 additional for this project to provide a heat sink at Government expense.
60-e-13	Experimental organic-cooled reactor	6,000	Design underway.
60-e-15	Power reactor of advanced design capable of utilizing nuclear superheat, to be undertaken either as a cooperative project or conducted solely by the AEC.	11,000	Do.
60-f-1	Miscellaneous modifications and additions, Argonne National Laboratory, Illinois.	1,000	Conceptual design underway.
60-g-2	Accelerator and reactor modifications, Brookhaven National Laboratory, New York.	1,950	Procurement of equipment principally; specifications being firmed up.
60-g-3	Transuranium Laboratory, Oak Ridge National Laboratory, Tennessee.	1,200	Construction expected to start 2d quarter calendar 1960.
60-g-4	Physics building, Lawrence Radiation Laboratory, California.	2,000	Preliminary engineering underway.
60-i-1	High-level radiation development laboratory	1,600	Conceptual design underway.
60-i-2	Radioisotope process development laboratory	1,500	Title I engineering almost complete; expect to request bids May 1960.
60-k-1	High school additions, Los Alamos, N. Mex	485	Design completed; construction scheduled to begin April 1960.
60-k-3	Housing alterations, Los Alamos, N. Mex	1,000	Design underway; construction scheduled to start April 1960.
Authorized by Public Law 85-590:			
59-a-4	A new waste storage installation, Arco, Idaho	3,200	Deferred pending decision on industrial participation.
59-c-9	Test assembly building	510	Design scheduled to start April 1960; construction, July 1960.
59-e-11	High flux research reactor, Brookhaven National Laboratory.	10,000	Architect-engineer selected January 1960.
59-e-15	Research reactor, Ames Laboratory	3,800	Do.
Authorized by Public Law 85-162:			
58-b-6	Additions to gaseous diffusion plants	6,600	Project requirements being reviewed.
Authorized by Public Law 84-506:			
57-a-6	Charging and discharging system, Hanford, Wash	3,450	Do.
57-d-4	Conversion of accelerator design building, University of California Radiation Laboratory.	300	Delayed pending completion of Engineering Services Building at UCRL.

TABLE 7.—*Analysis of unexpended balances projected for June 30, 1960*

[Millions]

Plant acquisition and construction:		
Unexpended balance of appropriations estimated at June 30, 1960		$517.7
Portion estimated to be obligated at June 30, 1960		517.7
Portion estimated to be unobligated at June 30, 1960		0
Total		517.7
Operating expenses:		
Unexpended balance of appropriations estimated at June 30, 1960		939.7
Portion estimated to be obligated at June 30, 1960		916.7
Goods and services on order:		
Major long-term reimbursements contracts	$532.4	
Major procurement	28.4	
Research and development	75.0	
Cooperative arrangements	62.1	
Utility contracts	2.4	
All other	26.3	
	726.6	
Less advances and prepayments	[1] 25.5	
Total unpaid undelivered orders	701.1	
Goods and services received but not paid for	215.6	
Portion estimated to be unobligated at June 30, 1960, to be applied against fiscal year 1961 obligational requirements		23.0
Total		939.7

[1] Advances and prepayments (goods and services on order not yet received) as shown under the category "Relation of costs to accrued expenditures," in the President's budget, p. 119.

TABLE 8.—*Comparison of items submitted to the Bureau of the Budget with items submitted to the Congress—1961 authorization bill*

Project title	Submitted to the Bureau of the Budget	Submitted to the Congress
Modifications to production and supporting installations	$12,000,000	$10,000,000
Billet production plant	1,800,000	1,800,000
Heat treatment and inspection modifications, Fernald, Ohio	2,500,000	2,500,000
Development laboratory building, Oak Ridge, Tenn	766,000	766,000
Plutonium reclamation plant, Hanford, Wash	3,500,000	2,900,000
Moderator purification improvements, Savannah River, S. C	2,500,000	2,500,000
Weapons production, development and test installations	10,000,000	10,000,000
High velocity test track, Sandia Base, N. Mex	2,100,000	2,100,000
Special metals fabrication plant	3,000,000	3,000,000
Tonopah Test Range, Tonopah, Nev	1,900,000	1,900,000
Contaminated waste plant, Los Alamos, N. Mex	2,000,000	2,000,000
Additions and modifications to Chemical Engineering Building, Argonne National Laboratory, Illinois	2,000,000	2,000,000
Special purpose test installation addition, Santa Susana, Calif	1,200,000	1,200,000
Technical space for SPERT, National Reactor Testing Station, Idaho	500,000	500,000
Critical building, Brookhaven National Laboratory, New York	600,000	600,000
Fast reactor core test installation, Los Alamos Scientific Laboratory, New Mexico	6,900,000	6,900,000
Plutonium fuel service and development building, Los Alamos Scientific Laboratory, New Mexico	600,000	600,000
Test installation for project Rover	20,000,000	20,000,000
Metallurgical development laboratory, Oak Ridge National Laboratory, Tennessee	1,600,000	0
Test installation for project Pluto	15,000,000	15,000,000
Heavy water natural uranium reactor	55,000,000	0
Advanced test reactor	24,000,000	24,000,000
Nuclear powerplant, remote military installation	11,600,000	0
Additions and modifications, MTR–ETR area, National Reactor Testing Station, Idaho	800,000	800,000
Site utilities, Brookhaven National Laboratory, New York	1,250,000	1,250,000
Quarters for visiting scientists, Brookhaven National Laboratory, New York	550,000	550,000
Bubble chamber house, Brookhaven National Laboratory, New York	1,660,000	1,660,000
Princeton-Pennsylvania accelerator addition, Princeton, N.J	1,350,000	1,350,000
Accelerator and reactor additions and modifications, Brookhaven National Laboratory, New York	1,285,000	1,285,000
High flux isotope reactor, Oak Ridge National Laboratory, Tennessee	12,000,000	12,000,000
Accelerator improvements, Lawrence Radiation Laboratory, California	950,000	950,000
Bevatron shielding, Lawrence Radiation Laboratory, California	1,100,000	1,100,000
Metallurgy building extension, Brookhaven National Laboratory, New York	655,000	655,000
Addition to cyclotron building, Lawrence Radiation Laboratory, California	500,000	500,000
Installations for support of biomedical research in atomic energy	4,000,000	4,000,000
Real estate development, Los Alamos, N. Mex	435,000	435,000
Elementary school addition, Los Alamos, N. Mex	145,000	145,000
Steam transmission line, Los Alamos, N. Mex	135,000	135,000
General plant projects	34,175,000	34,175,000
Total	242,056,000	171,256,000

TABLE 9.—*Comparison of submission to the Bureau of the Budget with the President's budget*

OPERATING EXPENSES APPROPRIATION, FISCAL YEAR 1961

[In millions]

Program	Submitted to BOB	President's budget	Difference
Accrued costs by program:			
Raw materials	$680.5	$630.0	−$50.5
Special nuclear materials	570.0	567.7	−2.3
Weapons	495.0	495.0	0
Reactor development	453.4	436.2	−17.2
Physical research	166.4	158.9	−7.5
Biology and medicine	54.2	54.2	0
Training, education, and information	14.2	14.2	0
Civilian applications of isotopes and nuclear explosives	13.0	12.5	−.5
Community	10.2	10.2	0
Program direction and administration	54.9	54.9	0
Security investigations	5.9	5.9	0
Other costs	6.5	6.5	0
Total accrued costs	2,524.2	2,446.2	−78.0
Increase or decrease in selected resources	21.4	26.7	+5.3
Total obligations for operating expenses	2,545.6	2,472.9	−72.7
Less revenues applied	22.6	22.6	0
Net obligations (financed by appropriated funds)	2,523.0	2,450.3	−72.7

Representative HOLIFIELD. This morning we are scheduled to hear from AEC Chairman John A. McCone, who will present a general statement as to the bill. Thereafter, we will hear from AEC General Manager Luedecke, and senior members of the AEC staff. Tomorrow the subcommittee will meet in executive session to discuss the classified projects of the bill, and then resume public hearings on Thursday of this week.

We are very glad to have you with us this morning, Mr. McCone. Please proceed.

STATEMENT OF JOHN A. McCONE, CHAIRMAN, ACCOMPANIED BY JOHN S. GRAHAM, COMMISSIONER; JOHN F. FLOBERG, COMMISSIONER; A. R. LUEDECKE, GENERAL MANAGER; LOREN K. OLSON, GENERAL COUNSEL; EDWARD J. BLOCH, ASSISTANT GENERAL MANAGER FOR MANUFACTURING; GEORGE F. QUINN, DIRECTOR, DIVISION OF PRODUCTION; BRIG. GEN. A. D. STARBIRD, DIRECTOR, DIVISION OF MILITARY APPLICATION; DR. FRANK K. PITTMAN, DIRECTOR, DIVISION OF REACTOR DEVELOPMENT; DR. CHARLES L. DUNHAM, DIRECTOR, DIVISION OF BIOLOGY AND MEDICINE; DR. PAUL W. McDANIEL, ACTING DIRECTOR, DIVISION OF RESEARCH; DR. PAUL AEBERSOLD, DIRECTOR, OFFICE OF ISOTOPES DEVELOPMENT; DON S. BURROWS, CONTROLLER, DIVISION OF FINANCE; FRANCIS J. McCARTHY, ASSISTANT CONTROLLER FOR BUDGETS, DIVISION OF FINANCE, ATOMIC ENERGY COMMISSION

Mr. McCONE. Thank you very much, Mr. Chairman and members of the committee.

GENERAL STATEMENT

The Atomic Energy Commission is appearing today before the Joint Committee on Atomic Energy to discuss proposed legislation to authorize appropriations for plant acquisition and construction and for cooperative programs. Legislative authority in these areas is enacted each year pursuant to section 261 of the Atomic Energy Act.

The various projects comprising our 1961 program are described in some detail in the analysis of the proposed bill, copies of which were provided to the committee some days ago.

My brief opening statement will attempt only to outline the scope of the bill, rather than describe the projects in detail. The General Manager and members of the staff are here to provide additional information about any project. A few of the projects relate to classified activities, concerning which detailed information should be discussed only in executive session.

SUMMARY

Amounts proposed for initial authorization together with changes in amounts previously authorized can be summarized as follows:

First, with respect to construction projects to be undertaken directly by the Government, section 101 of the bill would authorize appropriation of $171,256,000 for new projects. In addition, section 107 proposes that amounts previously authorized for two projects be increased by a total of $19 million. Rescission is proposed for seven construction projects which were authorized in earlier years but which experience has shown can be eliminated from the program.

Secondly, with respect to cooperative arrangements under our domestic power reactor demonstration program, section 109 of the bill would increase by $40 million the amount authorized to be appropriated for use by the Commission in this program, and would increase by $5 million the amount of charges the Commission is authorized to waive for the use of special nuclear materials and heavy water in research and development related to cooperative projects.

Finally, section 110 of the proposed bill would authorize to be appropriated $5 million for use in a cooperative program of research and development with Canada.

NEW CONSTRUCTION PROJECTS

The new projects proposed for construction by the Government and having a total estimated cost of $171,256,000 may be categorized as follows:

For our programs dealing with special nuclear materials and weapons we have proposed eleven projects representing 23 percent of the total cost, or about $39,500,000. Projects for the reactor development program are 12 in number and represent about 43 percent of the total cost, $73,400,000. The nine projects in support of our research programs in the physical and life sciences represent $23,500,000 or 14 percent of the total. Three community construction projects for Los Alamos total about $700,000, or less than 1 percent. The remaining $34,175,000 for general plant projects is applicable to all of the establishments of the Commission and represents about 20 percent of the total.

STANFORD ACCELERATOR

The bill does not include any provision for the Stanford accelerator. A request for the authorization of this project was submitted to your committee last year. Your committee deferred consideration of the request pending the development of further information. Since that time further data have been developed, including an independent study and report by Blume & Associates on the site problem and design and construction costs. This report has recently been furnished to your committee and is being studied within the administration. We will advise you of further development.

Representative HOLIFIELD. At that point, can you tell the committee when you will submit to us AEC recommendations on this project?

Mr. MCCONE. We will be prepared to do so within 10 days.

Chairman ANDERSON. We have had some questions, Mr. Chairman, about what we are doing about it. Would you not agree that the

Joint Committee should not do very much about it until we do get the recommendations from the Atomic Energy Commission?

Mr. McCone. I agree with that.

Chairman Anderson. Thank you.

SPECIAL NUCLEAR MATERIALS PROGRAM

Mr. McCone. Special nuclear materials projects: For the special nuclear materials program, we have requested authorization, as in other recent years, for the construction of plant additions and modifications not specifically identified in advance, but which may be required to be undertaken during the year in order to meet changes in plant capabilities and for safety or economy of operations. The amount proposed for this purpose is $10 million.

Additional specific projects are a plant for reclaiming plutonium at Hanford, estimated to cost $2,900,000; additions at Savannah River to improve the purification of the heavy water moderator during operation of the reactors, estimated at $2,500,000; two additions to our feed material facilities, estimated to cost $4,300,000, and a development laboratory building costing $766,000, planned for Oak Ridge.

Representative Holifield. Mr. Chairman, when will the study of the AEC and the Federal Power Commission on the new Hanford convertible reactor be submitted to the Joint Committee?

Mr. McCone. We have received only a draft of it.

I understand that the final version will be presented to us momentarily and immediately upon receipt of it we will submit it to the committee, and following that we will submit our analysis of it. We have made an analysis—a preliminary analysis—of the draft report. It is an extremely complicated study. We will be very glad to submit this preliminary analysis to you, if the staff has not already done so.

Representative Holifield. Thank you.

WEAPONS PROGRAM

Mr. McCone. Weapons projects: In the weapons program we have also proposed authorization of a general project of $10 million to make funds available for facilities to meet new production requirements and to provide research and development facilities needed to take early advantage of advances and changes in weapons technology.

The four other projects, totaling $9 million, are a special metals fabrication plant, a high velocity test track at Sandia Base, a treatment plant at Los Alamos for radioactive waste, and additional facilities at the Tonopah Test Range. Since submitting the proposed bill we have found that the Tonopah project, 61–c–1, for $1,900,000 can be eliminated. We now believe we can accommodate any minor construction necessary from other available funds.

Representative Holifield. Would that item be subtracted from your total of $171 million?

Mr. McCone. Yes, that will be.

Representative Holifield. That would reduce the amount by that much?

Mr. McCone. It would reduce it by $1,900,000.

Representative DURHAM. You mention the four projects for $9 million; is that itemized in your breakdown?

Mr. MCCONE. It is itemized in the breakdown.

Representative DURHAM. Is that special metals fabrication plant a new facility entirely for the fabrication of metals?

Mr. MCCONE. Yes. It is a new facility.

Representative DURHAM. If that will be discussed in executive session, I won't pursue it any further.

Representative HOLIFIELD. We will discuss the matter tomorrow morning.

Mr. MCCONE. It will be discussed in detail.

REACTOR DEVELOPMENT PROGRAM

Reactor development projects: For the missile propulsion area there are proposed a $20 million test installation for Project Rover, nuclear rocket propulsion, and a $15 million test installation for Project Pluto, nuclear ramjet propulsion.

Two facilities proposed for the Los Alamos Scientific Laboratory at a cost of $7,500,000 are the fast reactor core test installation and a building for plutonium fuel fabrication for the expanded experimental program.

Three projects planned for the Brookhaven National Laboratory at a combined cost of $2,400,000 include a building in which to perform critical experiments, provision of increased capacity in the steam and electric power distribution systems, and erection of badly needed quarters for visiting scientists.

At Argonne National Laboratory additions and modifications to provide a gamma analyzer facility and additional chemistry laboratories to the Chemical Engineering Building are planned at a cost of $2 million.

Two projects are planned at the National Reactor Testing Station at a cost of $1,300,000. These are a control building for the technical personnel engaged in reactor safety studies with the various SPERT facilities, and an addition to the reactor services building to house engineers, draftsmen, and sponsor representatives working with the materials testing reactor and the engineering test reactor. The remaining reactor development project is a $1,200,000 addition at Santa Susana, Calif., to provide greater testing capability for the SNAP program.

Chairman ANDERSON. At one time I addressed to the chairman of the Atomic Energy Commission a letter with reference to project Rover. In the beginning of his paragraph he mentions the fact that $20 million is now requested for authorization. I would like to have permission to insert in the record at this point the original letter to the Atomic Energy Commission with reference to project Rover and the reply of Mr. Floberg under date of March 7, pointing out that the Commission has been able to make available the full amount of money needed for construction during fiscal year 1961. I also addressed a

letter to Dr. T. Keith Glennan, Administrator, National Aeronautics and Space Committee, which I would also like to have in the record.

Representative HOLIFIELD. Without objection, it will be received.

(The letters referred to follow:)

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
March 1, 1960.

Dr. T. KEITH GLENNAN,
Administrator, National Aeronautics and Space Administration,
Washington, D.C.

DEAR DR. GLENNAN: This is with reference to our hearings on the Rover project on February 15 and to inquire as to what progress has been made since that time.

At the hearing I was happy to learn that AEC was partially successful in its efforts to obtain restoration of its Rover authorization and funding request. I was also gratified to find that although NASA did not initially support the AEC appeal it did so subsequently. I was also glad to learn that NASA is apparently making more of an effort to delegate responsibility and generally cooperate in expediting the Rover project.

I was disappointed, however, to find that NASA still has not established any objectives or target dates for the flight testing of a nuclear rocket. As I indicated in my statement following the February 15 hearing (copy attached), I believe it is extremely necessary to establish some firm objectives and target dates for the flight testing of the nuclear rocket. In establishing this objective and these dates, it will then be possible to work backwards to develop our schedule for the next few years to achieve these goals. This would include bringing in an industrial contractor at an early date to work with the Los Alamos Laboratory and certain organizational rearrangements for the direction and support of the project.

I frankly doubt that very effective administration of a project of this nature can be achieved through policy direction provided by an interagency coordinating committee. I believe that one man and one staff should provide the overall project direction as has been done in the case of nuclear submarine development under Admiral Rickover. This staff in turn should include personnel from NASA, AEC, and possibly the Department of Defense. Such a director and staff should have real technical and budgetary authority and responsibility, and probably should be located in AEC.

If the flight test objective and target dates were established, and if the overall direction of the project were assigned to one organization, I believe that the success of the project would have greater assurance. Undoubtedly additional funds would be required for 1962 and thereafter, and possibly late in fiscal year 1961. I am prepared to do everything in my power to see that such funds are authorized and appropriated.

But the most important thing to get this project "off the ground" is that there must be a genuine sense of enthusiasm and urgency at the highest levels to give impetus to the project. I believe this condition does exist in the Joint Committee and the Space Committees of the Congress. I have been heartened by by the increasing support of Mr. McCone and the AEC for this project. I only wish that the rest of the executive branch, and particularly NASA and the Bureau of the Budget, would show a greater interest in the project. To help crystallize some of this interest I hope to arrange an informal discussion of interested parties within the near future. I hope you will be able to attend.

Sincerely yours,

CLINTON P. ANDERSON, *Chairman.*

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
March 1, 1960.

Hon JOHN A. MCCONE,
Chairman, U.S. Atomic Energy Commission, Washington, D.C.

DEAR MR. MCCONE: This is with reference to our hearing on the Rover project on February 15 and to inquire as to what progress has been made since that time.

I was happy to learn that AEC was partially successful in its efforts to obtain restoration of its Rover authorization and funding request. I would appreciate receiving information as soon as possible on your reprograming efforts to obtain funds for Rover facilities and operation for fiscal year 1961. Of course, this requirement should not interfere with other important AEC programs. I fully intend to make every effort to obtain the necessary appropriations for this and other urgent projects. A copy of the Bureau of the Budget letter which you received on February 15, which was mentioned at our hearing, would be helpful for our records.

As I indicated in my statement following the February 15 hearings (copy attached), I believe it is necessary to establish some firm objectives and target dates for the flight testing of a nuclear rocket. In establishing this objective and these dates, it will then be possible to work backward to develop our schedule for the next few years to achieve these goals. This would include bringing in an industrial contractor at an early date to work with the Los Alamos Laboratory and certain organizational rearrangements for the direction and support of this project.

I frankly doubt that very effective administration of a project of this nature can be achieved through policy direction provided by an interagency coordinating committee. I believe that one man and one staff should provide the overall project direction as has been done in the case of the nuclear submarine under Admiral Rickover. This staff in turn should include personnel from NASA, AEC, and possibly the Department of Defense. Such a director and staff should have real technical and budgetary authority and responsibility.

If the flight test objective and target dates were established, and if the direction of the project were reorganized, I believe that we would be well on our way toward an accelerated nuclear rocket program. Undoubtedly additional funds would be required for 1962 and thereafter, and possibly late in fiscal year 1961. I am prepared to do everything in my power to see that such funds are authorized and appropriated.

But the most important thing to get this project "off the ground" is that there must be a genuine sense of enthusiasm and urgency at the highest levels to give impetus to the project. I believe this condition does exist in the Joint Committee and the Space Committees of the Congress. I was heartened by your increasing support of the project and only hope that the rest of the executive branch, and particularly NASA and the Bureau of the Budget, show a similar degree of interest. To help crystallize some of this interest I hope to arrange an informal discussion of interested parties within the near future. I hope you will be able to attend.

Sincerely yours,

CLINTON P. ANDERSON, *Chairman.*

Enclosure, copy of Senator Anderson's statement of February 15, 1960.

[Release No. 256]

STATEMENT BY SENATOR CLINTON P. ANDERSON, CHAIRMAN OF THE JOINT COMMITTEE ON ATOMIC ENERGY, FOLLOWING CLOSED HEARING BY THE JOINT COMMITTEE ON ROVER NUCLEAR ROCKET PROJECT, MONDAY, FEBRUARY 15, 1960

The Joint Committee on Atomic Energy held a hearing today on the status and prospects of the Nation's nuclear rocket project, called Project Rover, to cover the topics announced in the JCAE statement last Tuesday, February 9.

This hearing was called because of concern about the reported cutbacks in AEC requests for construction and operating funds for the Rover program and to inquire about whether, as a result of the successful ground test experiment by the Los Alamos Laboratory at the Nevada Test Site in July 1959, the program should not be accelerated rather than decelerated.

In order to discuss more concretely means of arriving at some definite program objectives, target dates, and organizational arrangements, which would expedite the program, our staff director wrote to the Commission and NASA, outlining our views on these matters. (Copy attached.)

In the hearing I was happy to find that John McCone, AEC Chairman, had appealed to the Bureau of the Budget last week to restore the funds for the Rover project. As I understand it, he was able to persuade them to request the full authorization of $20 million for facilities for the project but was unable to obtain any relief on actual construction funds for fiscal year 1961 or for operating funds, except by reprograming. Nonetheless, his strong support of the program is encouraging.

It was further brought out that the results of these budget cuts could stretch out the target date for feasibility ground tests of the nuclear rocket engine by at least a year. No firm objectives for flight testing of a nuclear rocket have been established, according to the testimony today but it was indicated that the general flight test dates have been moved back 2 years.

The AEC has now declassified the funding arrangements and some of the target dates for the Rover project. These may be summarized as follows:

	Original date	Wilson stretchout (1957)	Current proposed stretchout
1. Target dates for ground test feasibility of rocket engine.	Target: 1960...	Target: 1963...	Target: 1964.
2. Target for flight test of nuclear rocket.....	Target: 1965...	Target: 1968...	Target: 1967–69.

	Original AEC request to Bureau of the Budget	Bureau of the Budget request to Congress	Remarks
Construction fund:			
Authorization.....	$20,000,000	$13,000,000	Revised by Bureau of the Budget to $20 000,000.
Funding for fiscal year 1961.....	13,000,000	5,000,000	$5 000 000.
Funding for fiscal year 1962.....	7,000,000	8,000,000	Unknown.
Operating funds: Funding for fiscal year 1961.	22,800,000	18,0..0,000	No change after AEC appeal.

This stretchout of the project and the lack of firm objectives and target dates should be a matter of great concern to the Congress and the Nation. As I pointed out in my opening statement at the hearings today (a copy of which is attached), the Director of our U.S. Information Service has indicated that our outer space propulsion program is of the greatest importance to the United States prestige in the world today.

Therefore, it would seem to be the part of wisdom to engage in a separate accelerated nuclear rocket program, a field in which we stand a chance to surpass the Russians in the next 10 years. Nothing in the testimony in our closed hearing indicated that the United States could not engage in a successful accelerated nuclear rocket program if the appropriations asked by AEC are supplemented somewhat and if a real impetus were given to the program at the highest governmental levels.

The Joint Committee and its staff intend to investigate this problem further. We intend to hold further hearings on this subject at appropriate times to see what progress can be made.

Attachments:

Opening statement of Chairman of JCAE at hearings February 15, 1960.
Copy of letter from JCAE to AEC and NASA, February 11, 1960.

OPENING STATEMENT BY SENATOR CLINTON P. ANDERSON, CHAIRMAN OF THE JOINT COMMITTEE ON ATOMIC ENERGY, AT HEARING ON THE ROVER NUCLEAR ROCKET PROJECT, FEBRUARY 15, 1960

I have called this hearing to look into the programs and plans for the Rover nuclear rocket project.

As you know, the Joint Committee on Atomic Energy has for a number of years concerned itself with the Rover nuclear rocket program. The interest of some of us goes back to early in 1955 when the nuclear rocket program was set up as a formal project at Los Alamos and Livermore.

Developments since then have confirmed our beliefs in the potential of nuclear rocket engines. The far greater prospect of growth of the nuclear system compared to advanced future chemical systems is one of the primary reasons for

our interest in the Rover project. As was brought out in our public hearings in February 1958, the nuclear rocket has a specific impulse 2½ times that of conventional chemically fueled rockets.

The importance of our space program was pointed out very succinctly by George V. Allen, Director of the U.S. Information Agency, in his testimony before the House Committee on Science and Astronautics on January 22, 1960, when he said:

"* * * our space program has an importance far beyond the field of the activity itself. * * * It bears on almost every aspect of our relations with people of other countries and on their view of us as compared with the U.S.S.R. Our space program may be considered as a measure of our vitality and our ability to compete with a formidable rival, and as a criterion of our ability to maintain technological eminence worthy of emulation by other peoples."

The importance of looking ahead more to systems of space propulsion with a real potential beyond the chemical system now receiving the most attention in the United States is brought out in Wernher von Braun's testimony before the same committee on February 2, 1960. Von Braun, during testimony concerning estimates of where the Russians would be when we finally developed the chemical Saturn system, said he thought we would have to keep running and that he thought that it was quite likely and logical that the Russians have much larger rockets under development.

Therefore, considering the importance of attaining leadership in the field of space propulsion technology and the great potential of nuclear propulsion compared to chemical rockets, we want to be assured that looking to the future, the Rover program is receiving the proper emphasis.

The recent cuts in Rover budget requests seem incongruous with the above situation. This apparent decrease in interest in the Rover program is particularly puzzling in the light of the successful nuclear rocket experiment conducted last July in Nevada.

That is why I have asked the Atomic Energy Commission, National Aeronautics Space Administration and Los Alamos Scientific Laboratory representatives to appear here today. We want to know what the status of the program is and what the objectives are.

We have sent letters to the AEC and NASA outlining the specific items we would like to go over today. These items are as follows:

1. Present status and plans for the Rover program;
2. The effect of cuts in budget requests for 1961 and thereafter, particularly in relation to facilities and advanced projects beyond the KIWI-type ground test reactor experiments;
3. The need for establishing objectives and target dates for the program, particularly as to a target for testing a flight prototype soon.
4. The facilities and manpower required for an expanded and accelerated program necessary to meet urgent objectives established under No. 3.
5. The effects and necessity of security classification on the Rover program.

I would like to place these letters in the record. We also sent an outline of suggested Rover program objectives, target dates and organization to the AEC and NASA on which we would like to receive your comments today. I would like to place this suggested outline in the record also.

Now I understand that Mr. McCone is going to lead off the testimony today.

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
February 11, 1960.

Dr. T. KEITH GLENNAN,
Administrator, National Aeronautics and Space Administration,
Washington, D.C.
Gen. A. R. LUEDECKE,
General Manager, U.S. Atomic Energy Commission,
Washington, D.C.:

As you know the Joint Committee is very interested in the early development of the nuclear rocket propulsion system under the Rover program. We are hopeful that something constructive will come from discussions at our hearing on this subject scheduled for Monday, February 15, 1960.

In order to facilitate discussions during the hearing Senator Anderson asked me to supplement his letter of February 8, 1960, to outline some objectives,

target dates, and organizational proposals for your consideration. We would appreciate your review and comments on these points during the hearing.

The suggested outline we have developed is aimed at first establishing firm operational objectives tied to a functional flight test schedule and with clear-cut organizational responsibilities for the program.

1. Basic performance specifications for the rocket engine for flight test should be established immediately. These performance specifications could be based on upper stage requirements for Saturn with a target date for launching from upper stage by 1966 or 1967. However, it appears more desirable to set performance requirements independent of the Saturn research and development program to eliminate dependence on the results of another research and development effort.

2. A schedule for research and development work to meet the requirements for the commencement of ground-launched prototype tests in 1964 should be established. If the 1964 date cannot now be met, what would be the earliest date for such tests and the required schedule for research and development?

3. Responsibility for the development of the nuclear rocket through the flight test phase of an integrated protoype propulsion system should be assigned to the Atomic Energy Commission, with the understanding that the Natural Aeronautics and Space Administration will provide the Commission with consultation and assistance.

Sincerely yours,

JAMES T. RAMEY,
Executive Director.

U.S. ATOMIC ENERGY COMMISSION,
Washington, D.C., March 7, 1960.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: In reference to your letter of March 1, 1960, regarding fiscal year 1961 funding of the Rover program, I am pleased to advise you of the following:

As you know, the Commission is proposing a project authorization of $20 million for test installations for the Rover program. Included in the budget submitted in January there was $5 million as the fiscal year 1961 funding increment for the project. This amount compares with $13 million included in the Commission's budget submission to the Bureau of the Budget. However, as a result of further review of the Commission's estimated plant acquisition and construction obligations, it is now possible to fund in 1961 the full $13 million included in our original submission. It has been determined that obligations planned in 1960 and 1961 for the following projects can be either eliminated or deferred:

	Millions
61–c–1. Tonopah Test Range, Tonopah, Nevada	$1.9
59–c–2. Base construction, Eniwetok Proving Ground	1.8
58–d–9. Base construction, Eniwetok Proving Ground	2.6
57–g–1. Additions to electrical power system, NRTS	1.7
Total	8.0

It should also be noted that our budget submission to the Bureau of the Budget included $22.8 million for 1961 operating costs for the Rover program as compared with $18 million included in the January budget submission. However, after review of the pace of the Euratom program, it is apparent that in lieu of the $5 million operating estimate for this program, $2 million represents a more realistic level. Accordingly, the $3 million difference has been applied to the Rover operating cost estimate to restore that program to a level of $21 million in 1961.

I trust that the fund adjustments outlined above will allay your concern with respect to the adequacy of the 1961 funding level of the Rover program.

Sincerely yours,

JOHN F. FLOBERG,
Acting Chairman.

Chairman ANDERSON. I want to say I personally appreciate very much the efforts of the members of the Atomic Energy Commission in putting this project on what I think is a better basis than the original Bureau of the Budget estimate, although on the same basis that the Atomic Energy Commission had originally supported.

Mr. MCCONE. It is now on the same basis that Dr. Bradbury thought was proper.

Chairman ANDERSON. Yes, it is; but it only got there through the hard work of the Atomic Energy Commission. I want to thank the Commission for taking that action.

Mr. MCCONE. We had to turn over a few rocks to find the money. As I told you in the 202 hearings, we were going to exhaust every means of attempting to find the money before we sought it in other ways. We were successful in finding it.

Chairman ANDERSON. Thank you.

LIAISON BETWEEN AEC AND NATIONAL AERONAUTICS AND SPACE AGENCY

Representative HOLIFIELD. I would like to ask you a general question at this time. I noticed in the Space Committee's authorization bill, which was considered yesterday on the floor, that there seem to be several items, running into several million dollars, which to some extent duplicate either the facilities or the work that the Atomic Energy Commission has been doing in certain fields of nuclear propulsion engines and other fields.

My question would be, is there any type of liaison between the AEC and NASA in order to utilize more completely facilities which the AEC has already constructed, and to prevent duplication of either projects or buildings and facilities by the NASA agency?

Mr. MCCONE. Mr. Holifield, I do not believe there is a duplication in this Rover area of nuclear propulsion.

Representative HOLIFIELD. I was not referring particularly to the Rover area.

Mr. MCCONE. As you know, and as we have discussed with the committee, there are certain parts of that program that NASA is funding, such as the pump and the liquid hydrogen end of it, and we, the AEC, are funding the reactor itself. That is carefully worked out so that there is no duplication.

Representative HOLIFIELD. Then the answer is that there is a liaison?

Mr. MCCONE. There is a close liaison. Perhaps what you are referring to is a reactor that NASA is about to complete at Sandusky, Ohio.

Representative HOLIFIELD. That was one of the items.

Mr. MCCONE. This is for environmental testing of components outside of the reactor and to study their behavior under assumed conditions of radiation.

We have had a number of meetings with NASA on various areas where we come together in order to avoid duplication and we intend to pursue this practice and to develop policies both within AEC and NASA so that there will be no duplication.

Representative HOLIFIELD. I hope this is explored fully because each new agency that is established seeks to set up its own empire and so often they ignore facilities which could be used. A great many of our facilities, such as our test laboratories that we already have constructed, are not being utilized to the fullest capacity.

I would hope that they would be utilized before additional facilities are built by the NASA agency.

Mr. McCone. It is not only the facilities that concern us, but also the technical staff that is required to operate the facilities and to evaluate the results. You can get a duplication of both facilities and scientific personnel, and that is something that we recognize and something that must be avoided.

Representative Durham. Mr. Chairman, that is the thing that struck me in this thing yesterday. I recall that there was $43 million in there for personnel. That is a lot of money.

Mr. McCone. I had not heard that.

Representative Durham. There is a situation of one agency robbing another of scientific personnel. I think that will have to be handled very carefully by the two agencies or else we will have serious duplications or taking personnel from one another.

I hope the Commission will watch it very closely because I can see where we are going to get into this field deeper and deeper.

Mr. McCone. I feel this is a very important point, not only with NASA but others. You may recall here a few months ago there was an article in the paper about the Bureau of Standards planning a big test reactor for their new location in Gaithersburg, Md. All of those things have to be very carefully considered because each facility creates a technical staff.

Representative Hosmer. Mr. Chairman, I would like to ask Mr. McCone if NASA has the same philosophical approach to this that you have just expressed.

Mr. McCone. I find no problem in that regard. They naturally want to be sure that whatever procedure is developed will meet their own mission.

Representative Hosmer. Let me ask you this, Mr. McCone. Does the Commission at the present time in its laboratories have any work going on of a research nature for NASA, that is additional to something you are directly cooperating upon?

Mr. McCone. You mean something other than Rover.

Representative Hosmer. Because you have the scientific teams and laboratories available which NASA has not.

Mr. McCone. You mean something other than Rover?

Representative Hosmer. Yes. Some work that they would do in a laboratory of their own or contract out to somebody else?

Mr. McCone. Let me ask our research people to answer that.

Representative Hosmer. I think that is actually a test of how well your cooperation is working.

Mr. McCone. Right now I am not aware of any. I would like to check that further.

(The following information was furnished by AEC:)

Excluding the cooperative efforts of AEC and NASA on the Snap and Rover programs, there has been and currently are areas of cooperation between the two agencies such as the following: Scientists engaged primarily on AEC work such as Project Sherwood have served and are serving on committees advisory to NASA.

The AEC is currently administering a contract for a research project sponsored by NASA at Donner Lab, LRL, University of California, at Berkeley, entitled "Biological Systems in Interplanetary Environment." AEC, on the other hand, has a purchase order issued by the Albuquerque Operations Office for use of the NASA wind tunnel at the California Institute of Technology. The agencies periodically exchange information on basic research work each is supporting. Such action assists the agencies in avoiding undesirable duplica-

tion of efforts. In addition visits have been made to AEC facilities by NASA representatives to investigate the facilities and processes of possible interest to NASA.

Representative HOSMER. That fact would more or less disturb the philosophy that you previously expressed, would it not?

Mr. MCCONE. That is right.

Representative HOSMER. Do you understand my question?

Mr. MCCONE. Yes I understand your question.

Chairman ANDERSON. I do hope, Mr. Chairman, that every effort is made in this direction. As you know, the NASA budget has mushroomed up to about a billion dollars. This is a pretty substantial figure. As you point out, they have $46 million for certain things that might be done for a fraction of that at existing plants of the Atomic Energy Commission where personnel have had to be put on a sort of standby basis because you are not doing certain test work.

I wrote a letter one time suggesting that certain facilities of the Atomic Energy Commission might be more or less leased to NASA, operated by AEC. The answer I got was, well, they were a few hundred miles distant.

I wonder whether or not the first answer was very well considered. I think it is going to take constant negotiation by Atomic Energy Commission officials to point out the excellent character of some of your staff people and the fine facilities you have for not only measuring and monitoring and evaluating these things, but the people who have had experience in evaluating these concepts in order to get the job done best for the Government. I do hope that work that has already been started will be continued.

I think Mr. Hosmer makes a very good point. If NASA has not found a single thing that the Atomic Energy Commission can do for it, the cooperation is probably not too close somewhere along the line.

Mr. MCCONE. I think it is a very good point. I have not heard $43 or $46 million figure before. This is disturbing to me. We are fortunate in the fact that Dr. Glennan, who is operating the NASA, is a former AEC Commissioner and hence he knows a good deal about what we can do.

Chairman ANDERSON. Yes, but the members of his staff who are scrambling for dollars are not former AEC Commissioners.

Mr. MCCONE. That is true.

Chairman ANDERSON. They have a perfect right to stake out whatever they can for their empire.

Representative DURHAM. Mr. Chairman, I stated those figures from memory. I believe they are correct. Of course, they can be corrected by the report which was filed yesterday by the committee on this organization.

I have great faith in them, too, because I don't think there are any finer scientists in the world than they have in the organization. They are good men. They have been with the old National Advisory Committee on Aeronautics for years.

When we started out with that committee years ago, we only had about 100 people. Now, we have wound up with millions of dollars for a new organization which is a part and parcel of the whole. I thought it was wise to consolidate the two.

Unfortunately, I handled all of their legislation for years and I hated to lose it. I thought it was a very wise decision by the President to do that.

Representative HOSMER. Mr. Chairman, I have just one other question. Is there anything other than the knowledge that reposes in Dr. Glennan and possibly a few other people in NASA of the facilities that you might have available or that they could use?

Mr. MCCONE. I think there are a number of men in Dr. Glennan's organization that are familiar with our facilities.

Representative HOSMER. But there is no formal way in which it can be ascertained that you could do a job for them that they have in mind?

Mr. MCCONE. No. That is, not in the sense that the Military Liaison Committee is a statutory committee which establishes in a formal manner the link between the Department of Defense and AEC. There is no such existing legislation.

There is an advisory and a guiding committee on the Rover project on which AEC and our laboratories as well as NASA are represented.

Representative HOSMER. I understand that. I was not speaking so much as to a formal legally established type of organization that could coordinate, but one that did exist on some rather steady basis.

Mr. MCCONE. The meetings that have been held have been informal inasmuch as they have been called by either NASA or by ourselves.

There is a memorandum of understanding now being negotiated and discussed between the two agencies concerning the handling of areas of mutual interest.

Representative DURHAM. As you go into this propulsion field from now on, that will be a kind of crisscross between your agency and theirs. It is bound to develop.

Mr. MCCONE. That is right. It is bound to develop.

Representative HOLIFIELD. I noticed two items yesterday and I don't care to sit in judgment on another committee's authorization, but it seemed to me that their item of $10 million on SNAP development was something which encroached upon the work already done in the AEC unless it is contemplated that they are going to furnish that $10 million for further development of SNAP for us in space vehicles.

I was wondering, in view of the long history of development of SNAP by AEC, whether NASA was going to go in and try to develop something similar to it or whether this was a new adaption.

Mr. MCCONE. I would like to ask General Branch, who is here, if he would speak to that. He is following this very closely. Or perhaps Colonel Armstrong would be more appropriate.

Representative HOLIFIELD. You understand my question, Colonel Armstrong: What relation the $10 million item in the NASA budget which was introduced yesterday on the floor relating to SNAP has to the work that has been done and is contemplated by the AEC in the SNAP program?

Colonel ARMSTRONG. The SNAP reactor for NASA is a 30-kilowatt electrical reactor. The rotating machinery and the parts external to the reactor which will convert the reactor heat into electricity is a responsibility of NASA. It is this conversion equipment which is involved in the $10 million, plus some additional study work that they are doing, looking toward 1 megawatt power ranges for space propulsion, ionic propulsion, and plasma propulsion.

Representative HOLIFIELD. So it is an extension rather than duplication of work?

Colonel ARMSTRONG. That is right.

NUCLEAR ENERGY VERSUS SOLAR ENERGY

Representative HOLIFIELD. While you are at the table, could you comment also on the $8 million item which seeks to develop solar energy for the same purpose, that is, as a device in a space vehicle?

If it has been correctly explained to me, the development of solar energy is going to involve the projection somehow or other into space of a tremendous reflecting shield which might be a hundred feet by a hundred feet or even larger, for the purpose of picking up enough solar energy to use in a space vehicle. This seems to be rather farfetched and seems to be a duplication, when you have already developed this SNAP device which could do anything and do it apparently quicker and easier than a solar device.

Colonel ARMSTRONG. As a sort of prejudiced nuclear person, I guess I really should not answer that question. There are competent people in the field who feel that the use of solar energy is a way to get electrical energy without adopting the problems of radiation that you find inherent in a reactor. These people are just as enthusiastic as we are, and you might say that there are two strings to the bow, how you get to large amounts of electrical energy in space. One is the nuclear approach. The other is the solar approach.

I realize that these are very difficult problems that you raise, these huge solar collectors being erected out in space, but there are people who feel that this is an engineering job that can be done.

Chairman ANDERSON. Is it not true that you have cut back your radioisotope program in the SNAP program because of lack of funds, but we have $10 million to put a big reflecting device up in space?

Colonel ARMSTRONG. I don't think, Senator Anderson, it was cut back because of lack of funds.

Chairman ANDERSON. Was it cut back? Let us get that established first.

Colonel ARMSTRONG. Yes.

Chairman ANDERSON. What was the reason?

Colonel ARMSTRONG. Our customer decided that he would rather use solar cells for that power range rather than isotopes.

Chairman ANDERSON. Who was your customer?

Colonel ARMSTRONG. The Air Force. So we had to terminate the program.

Representative DURHAM. There is one fact, that the organic act set up an advisory committee and Mr. McCone, the chairman of AEC, sits on that committee.

Mr. MCCONE. Yes. That legislation is in the process of being reconsidered.

Representative DURHAM. Do you meet very often? Have you sat in on meetings?

Mr. MCCONE. Yes, there have been frequent meetings of the Space Council. I do not think that the question of the choice between nuclear energy as a source of power or solar energy as a source of power has been made by the Space Council. We recognize both our sources of power and it has been more or less up to the operators of the agencies to decide the extent to which they wanted to develop one or the other or both.

Representative DURHAM. I hope you will be vigilant as an individual representing us so that it will be carried out in a manner which will protect our jurisdiction.

Mr. McCone. The SNAP device developments have been very satisfactory. This committee is thoroughly familiar with them. We have been somewhat disappointed in our acceptance.

Chairman Anderson. Let me pursue this a little bit.

Colonel Armstrong, you wear 2 hats, and General Branch also wears 2 hats, 1 of the 2 hats in each case being the Air Force.

Can you give us any explanation why your customer, the Air Force, did not want to proceed with this very fine thing? Is it that nuclear devices are not made by commercial companies?

Colonel Armstrong. The radioisotope device is being made by a commercial company, the Martin Co. at Baltimore. I can give you the reason. Whether it is a satisfactory reason or not, I can't guarantee.

Chairman Anderson. I would be happy to have it, satisfactory or not.

Colonel Armstrong. In the particular mission that they were talking about for the radioistope SNAP 1–A, they were talking in terms of 250 to 500 watts of electrical power. To do this economically, one would have to use cerium. Cerium is a gamma emitter and has to be very heavily shielded at the time you are handling it and at the launchsite.

We had a liquid shielding system wherein during the countdown the liquid shielding would be released, relieving the vehicle from the weight of this shielding. The vehicle intrinsically could not stand the weight of the shielding involved here without considerable change in the vehicle itself. They felt quite sure that they could reach the 250-watt level with solar cells without this added problem, so that they decided to go with what they felt was the easier route.

When I said a few minutes ago that we had canceled SNAP 1–A, I think I should qualify that by saying we are not carrying it through its entire testing period for shock vibration and all of the atmospheric conditions that you would meet in a launch.

We are, however, carrying one unit forward to ground test so that in the event there is any problem with the solar cell system, we do have this one on the shelf ready to go.

Mr. Ramey. Has NASA indicated any thoughts that if you were to develop a device of this sort they might be able to use it?

Colonel Armstrong. I don't want to say or leave the impression with you that radioisotope power sources are dead by any manner of means. We have several indicated requirements for radioisotope devices. These are to be used in cases where solar cells cannot be used. There is no other choice. So we are working actively on several different small units for NASA use in the event the requirement becomes firm and we are asked to proceed to a finished product.

Mr. Ramey. Aren't you in a sort of circle argument that you have to have a requirement from NASA or the Air Force to go ahead. But the NASA and the Air Force say to you, well, when you get a machine that will work we will take it?

Colonel Armstrong. In this particular case, I must say that we do not have a firm requirement for these devices but the Commission has supported our budget request, and we are actively pursuing these various conversion techniques.

Chairman ANDERSON. It is pretty close to what he said, though. You do not have a requirement, therefore you do not go ahead very fast. Until you go ahead very fast, there will not be any requirement. It is just round and round and round.

Colonel ARMSTRONG. I would have to admit that we are not going as fast as perhaps one could, but we are proceeding very satisfactorily on these radioisotope units. We do have them on the shelf ready to go as soon as the customer wants some of them.

Representative HOLIFIELD. Is it not true that you are much further advanced in your SNAP device and your radioisotope devices than you are in the solar field?

Colonel ARMSTRONG. There is no question about this.

Representative HOLIFIELD. I mean here you are with an instrument which all of us have seen and know it works. Yet for some unknown reason we set it on the shelf, so to speak, or we slow up its development, and we proceed off on a tangent on something which is very difficult from a mechanical standpoint to put these giant reflectors up in space large enough to absorb enough of the solar energy to actually run a turbine or a communications device. It may be possible and probably some day will be done, but the mechanical breakthrough that is necessary to get this large reflector up into the air, it seems to me, is far in the future. It would seem that you would go ahead and have a more active program of developing the SNAP device which has already proven to be successful.

In these days, when you are fighting for every million dollars that goes into anything, it seems that it is unnecessary to go off on a tangent in a completely new field when you already have this device which seems to most of us to be very successful and practically in the stage of use.

Mr. MCCONE. I think that is right, Mr. Holifield. The development has come along to a point where it can be used in the several devices with which you are completely familiar.

There is, however, a safety problem that has concerned the using agencies and also concerned us. We have established an advisory committee who are intensely studying just how serious that problem is. I think this has been one of the questions that has caused the using agencies to look with greater favor on the solar system.

Representative HOLIFIELD. That may be true. Your operation of this SNAP device out in space is an operation which does require shielding at this time.

I hope these things will be looked at and that there will be some kind of liaison between AEC and NASA to keep these people from running wild.

Congress gave a new agency $915 million and they are liable to find all kinds of fanciful, fantastic financial schemes and they may overlook something which they didn't originate or which is already in being which they could use. It is not your fault.

Mr. MCCONE. I can assure you that every effort will be made by the AEC in this regard.

Shall I proceed?

Representative HOLIFIELD. Yes, please.

REACTOR DEVELOPMENT PROGRAM

Mr. McCONE. The largest project proposed in the reactor development program is $24 million for an advanced test reactor. This reactor would provide higher neutron fluxes than will be available in any other facility—fluxes necessary for development of high-performance power reactors.

We have recently conducted a survey from which we determine that there is no current industrial need for high flux irradiation services. Since the need for the services is confined to Government requirements, we believe it to be appropriate for the Government to construct this reactor for its own account.

(The survey referred to follows:)

SURVEY OF INDUSTRIAL REQUIREMENTS FOR GENERAL TESTING REACTORS FOR THE PERIOD 1960 THROUGH 1965

Prepared by Staff of Division of Reactor Development, Atomic Energy Commission, October 1959

This report contains the results of the Atomic Energy Commission's survey of industrial requirements for general testing reactors for the period 1960 through 1965.

Of the 185 companies surveyed, 110 responded; 28 indicated requirements. It should be noted that respondents were requested to omit irradiations to be performed under Commission contract or in connection with cooperative arrangements with the Commission. Attached as appendix B are copies of the survey form (Form AEC–487), the forwarding letter and "Sheet of Instructions."

This report consists of three parts. Part 1 pertains to capsule tests, part II covers loop tests, and part III compares industrial requirements with the capacity of typical test reactors. Tables 1–1 through 1–4 in part I and 2–1 through 2–4 of part II are summaries of the reported data according to characteristics of the tests. Tables 1–5 of part I and 2–5 of part II contain a composite of the raw data for the capsule and loop test requirements, respectively.

In calculating maximum test requirements, tests of less than 6 months' duration were included as 6-month tests, tests of 6 to 12 months' duration were included as 12-month tests, and tests over 12 months' duration were included as 18-month tests. Test requirements for the years 1962 through 1965 were reported on a yearly basis. In order to show requirements for 6-month periods, the annual requirements were evenly divided between the first and last half of each year.

PART I -- CAPSULE TEST REQUIREMENTS

TABLE 1-1 Maximum Estimated Requirements for Capsule Tests

FIRMNESS	NUMBER OF TESTS TO BE PERFORMED DURING THE FOLLOWING TIME PERIODS												
	TOTAL	1960*		1961		1962		1963		1964		1965	
		1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
FIRM	126	25	18	12	12	12	11	14	14	2	2	2	2
LESS FIRM	462	49	72	68	57	28	27	27	26	26	26	28	28
SPECULATIVE	1021	8	99	141	160	107	92	83	76	71	69	59	56
TOTAL	1609	82	189	221	229	147	130	124	116	99	97	89	86

TABLE 1-2 Maximum Estimated Requirements for Capsule Tests by Flux

AV'G FLUX X 10^{-14}	NUMBER OF TESTS TO BE PERFORMED DURING THE FOLLOWING TIME PERIODS												
	TOTAL	1960		1961		1962		1963		1964		1965	
		1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Under 1													
FIRM	31	10	6	4	3	1	1	1	1	1	1	1	1
LESS FIRM	138	22	26	25	19	10	9	6	5	4	4	4	4
SPECULATIVE	258	2	18	40	54	40	30	21	16	13	12	7	5
TOTAL	427	34	50	69	76	51	40	28	22	18	17	12	10
1 to 2.5													
FIRM	80	11	10	7	8	10	10	12	12	0	0	0	0
LESS FIRM	101	13	18	25	21	3	3	3	3	3	3	3	3
SPECULATIVE	632	3	75	87	92	59	51	49	46	45	43	41	41
TOTAL	813	27	103	119	121	72	64	64	61	48	46	44	44
2.5 to 5													
FIRM	9	0	0	1	1	1	0	1	1	1	1	1	1
LESS FIRM	131	9	21	10	9	9	8	10	9	11	10	13	12
SPECULATIVE	92	3	5	7	5	5	7	10	10	10	10	10	10
TOTAL	232	12	26	18	15	15	15	21	20	22	21	24	23
Over 5													
FIRM	6	4	2	0	0	0	0	0	0	0	0	0	0
LESS FIRM	92	5	7	8	8	7	6	9	8	9	8	9	8
SPECULATIVE	39	0	1	7	9	4	4	4	3	4	3	0	0
TOTAL	137	9	10	15	17	11	10	13	11	13	11	9	8

*Calendar years are used throughout this report

PART I -- CAPSULE TEST REQUIREMENTS

TABLE 1-3 Maximum Estimated Requirements for Capsule Tests by Diameter of Holes

DIAMETER OF HOLES (INCHES)	NUMBER OF TESTS TO BE PERFORMED DURING THE FOLLOWING TIME PERIODS												
	TOTAL	1960		1961		1962		1963		1964		1965	
Under 1-1/8		1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
FIRM	2	1	1	0	0	0	0	0	0	0	0	0	0
LESS FIRM	122	10	12	9	9	9	8	10	9	11	10	13	12
SPECULATIVE	106	1	9	22	23	13	9	6	5	6	6	3	3
TOTAL	230	12	22	21	32	22	17	16	14	17	16	16	15
1-1/8 to 3													
FIRM	98	21	15	8	10	10	10	12	12	0	0	0	0
LESS FIRM	151	29	43	39	24	4	3	2	1	2	1	2	1
SPECULATIVE	784	7	84	116	123	69	62	62	59	56	54	47	45
TOTAL	1033	57	142	163	157	83	75	76	72	58	55	49	46
Over 3													
FIRM	26	3	2	4	2	2	1	2	2	2	2	2	2
LESS FIRM	189	10	17	20	24	16	15	16	15	14	14	14	14
SPECULATIVE	131	0	6	3	14	25	21	16	12	10	8	8	8
TOTAL	346	13	25	27	40	43	37	34	29	26	24	24	24

PART I -- CAPSULE TEST REQUIREMENTS

TABLE 1-4 Maximum Estimated Requirements for Capsule Tests by Capsule Length

CAPSULE LENGTH (INCHES)	NUMBER OF TESTS TO BE PERFORMED DURING THE FOLLOWING TIME PERIODS												
	TOTAL	1960		1961		1962		1963		1964		1965	
		1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
A. Instrumented													
Under 6													
FIRM	3	2	1	0	0	0	0	0	0	0	0	0	0
LESS FIRM	6	3	3	0	0	0	0	0	0	0	0	0	0
SPECULATIVE	74	0	6	10	22	9	5	5	5	5	5	2	0
TOTAL	83	5	10	10	22	9	5	5	5	5	5	2	0
6 to 12													
FIRM	23	1	3	2	2	2	1	2	2	2	2	2	2
LESS FIRM	121	6	10	16	16	10	9	10	10	9	8	9	8
SPECULATIVE	501	2	45	51	58	55	48	46	41	39	39	39	38
TOTAL	645	9	58	69	76	67	58	58	53	50	49	50	48
Over 12													
FIRM	19	13	6	0	0	0	0	0	0	0	0	0	0
LESS FIRM	63	2	2	5	7	6	5	6	6	6	6	6	6
SPECULATIVE	100	0	7	22	22	11	10	8	7	5	3	3	2
TOTAL	182	15	15	27	29	17	15	14	13	11	9	9	8
B. Not Instrumented													
Under 6													
FIRM	80	8	8	10	10	10	10	12	12	0	0	0	0
LESS FIRM	152	13	27	13	13	9	9	10	10	11	11	13	13
SPECULATIVE	100	2	11	16	16	8	7	8	7	9	8	4	4
TOTAL	332	23	46	39	39	27	26	30	29	20	19	17	17
6 to 12													
FIRM	0	0	0	0	0	0	0	0	0	0	0	0	0
LESS FIRM	95	22	22	24	17	4	3	1	0	1	0	1	0
SPECULATIVE	219	3	27	33	36	24	19	16	13	13	13	11	11
TOTAL	314	25	49	57	53	28	22	17	13	14	13	12	11
Over 12													
FIRM	1	1	0	0	0	0	0	0	0	0	0	0	0
LESS FIRM	25	3	8	10	4	0	0	0	0	0	0	0	0
SPECULATIVE	27	1	3	9	6	5	1	1	1	0	0	0	0
TOTAL	53	5	11	19	10	5	1	1	1	0	0	0	0

TABLE 1-5 COMPOSITE OF CAPSULE TEST REQUIREMENTS

Item	CHARACTERISTICS OF TESTS																				NUMBER OF TESTS WITH SPECIFIED CHARACTERISTICS TO BE INITIATED IN FOLLOWING TIME PERIODS:							
	Duration of Tests (Months)			Av'g Flux X 10^{-14}				Diameter of Holes (Inches)			Capsule Length (Inches) Instrumented			Not Instr'd			Firmness of Requirements			1960		1961					
	Under 6	6 to 12	Over 12	Under 1	1 to 2.5	2.5 to 5	Over 5	Under 1-1/8	1-1/8 to 3	Over 3	Under 6	6 to 12	Over 12	Under 6	6 to 12	Over 12	Firm	Less Firm	Speculative	1st Half	2nd Half	1st Half	2nd Half	1962	1963	1964	1965
1	X			X				X						X			X			1	1						
2	X			X					X					X			X			2	2	2	2				
3	X			X					X				X				X			4	2						
4	X			X						X		X					X			1	1	1	1	2	2	2	2
5	X			X						X				X			X			2		1					
6	X				X				X							X	X			1							
7	X				X				X		X						X			2	1						
8	X				X				X			X					X				2						
9	X				X				X				X				X			5	2						
10	X				X				X					X			X			3	4	6	8	20	24		
11	X				X					X				X			X				1	1					
12	X					X				X		X					X					1	1	1	2	2	2
13	X						X		X				X				X			4	2						
14	X			X				X				X						X		1							
15	X			X					X					X				X		5	5	2	1	1	1	1	1
16	X			X					X						X			X		10	9	12	6	6			
17	X			X						X				X				X		3	5	3	3				
18	X			X						X		X						X			3	4	6	6	3		
19	X			X						X			X					X		1	1	2	3	6	7	7	7
20	X				X			X						X				X		1	1	1	1	1	1	1	1
21	X				X				X						X			X		10	10	10	10				
22	X				X				X			X						X				3	2				
23	X				X				X				X					X				1	1				
24	X				X					X			X					X				1	3	5	5	5	5
25	X					X		X						X				X		4	6	7	8	16	18	20	24
26	X					X		X			X							X		3	3						
27	X					X			X					X				X			10						
28	X					X				X					X			X		1	1	1	1	1	1	1	1
29	X					X				X		X						X				1					

TABLE 1-5

COMPOSITE OF CAPSULE TEST REQUIREMENTS

Item	CHARACTERISTICS OF TESTS																			NUMBER OF TESTS WITH SPECIFIED CHARACTERISTICS TO BE INITIATED IN FOLLOWING TIME PERIODS:							
	Duration of Tests (Months)			Av'g Flux X 10^{-14}				Diameter of Holes (Inches)			Capsule Length (Inches) Instrumented			Capsule Length (Inches) Not Instr'd			Firmness of Requirements			1960		1961		1962	1963	1964	1965
	Under 6	6 to 12	Over 12	Under 1	1 to 2.5	2.5 to 5	Over 5	Under 1-1/8	1-1/8 to 3	Over 3	Under 6	6 to 12	Over 12	Under 6	6 to 12	Over 12	Firm	Less Firm	Specu-lative	1st Half	2nd Half	1st Half	2nd Half				
1	X						X		X			X						X						2	2	2
2	X						X			X		X						X		3	3	3	3	3	5	5	5
3		X		X				X							X			X		1	1						
4		X			X				X							X		X		2	5	4					
5		X					X			X		X						X		1	1	1	1	2	2	2	2
6			X	X					X							X		X		1							
7			X			X			X				X					X		1							
8			X				X			X		X						X		1	1	1	1	2	2	2	2
9	X			X				X						X					X	1	1	10	3	4	3	4	4
10	X			X				X							X				X		2	3	3				
11	X			X				X								X			X				3				
12	X			X					X					X					X		1	1	1	2	2	1	1
13	X			X					X						X				X							1	1
14	X			X					X		X								X		3	3	12				
15	X			X					X			X							X		1	2	2	6	6	3	1
16	X			X					X				X						X			4	4	2	2	2	2
17	X			X						X					X				X		6						
18	X			X						X			X						X			1		2	3	1	1
19	X				X			X						X					X		6		6	6	6	6	
20	X				X				X					X					X		2	2	2	2	2	2	2
21	X				X				X			X							X		33	28	28	43	43	43	44
22	X				X				X				X						X			4	4	2	2	2	2
23	X				X					X		X							X							1	2
24	X					X			X					X					X	1	1	1	1	1	1	1	1
25	X					X			X		X								X				1	1			
26	X					X			X			X							X	2	2	2	2	2	3	3	2
27	X					X				X					X				X					1	1	1	1
28	X					X				X			X						X			1		1			
29	X						X	X						X					X			2	3				

(Chart continued from page 57)

Item	Duration of Tests (Months)			Av'g Flux X 10^{-14}				Diameter of Holes (Inches)			Capsule Length (Inches) Instrumented			Capsule Length (Inches) Not Instr'd			Firmness of Requirements			Number of tests with specified characteristics to be initiated in following time periods:							
																				1960		1961					
	Under 6	6 to 12	Over 12	Under 1	1 to 2.5	2.5 to 5	Over 5	Under 1-1/8	1-1/8 to 3	Over 3	Under 6	6 to 12	Over 12	Under 6	6 to 12	Over 12	Firm	Less Firm	Specu-lative	1st Half	2nd Half	1st Half	2nd Half	1962	1963	1964	1965
1	X						X		X					X					X						1	3	
2	X						X		X						X				X		1	2	3	3	4	4	
3	X						X		X				X						X			3	3				
4	X						X			X		X												2			
5	X						X			X						X			X					1			
6		X		X					X		X								X		3	4	5	5	5	5	
7		X		X					X			X							X			2					
8		X		X						X		X							X				10	10			
9		X			X			X							X				X			1	1	1	1	1	1
10		X			X				X						X				X		7	6	6	6	6	6	6
11		X			X				X			X							X		9	8	6	7	6	6	6
12		X			X					X						X			X			1	1	1	1		
13		X				X			X			X							X						2	2	2
14		X				X			X				X						X		2	1					
15		X				X				X		X							X					2	5	6	6
16		X					X			X			X						X					1	1		
17			X	X				X							X				X			3	3				
18			X	X					X							X			X	1							
19			X	X						X			X						X				2	2	2		
20			X		X				X						X				X	3	8		2	5	2	2	2
21			X		X				X							X			X		2	2					
22			X		X				X				X						X		5	1	2				
23			X		X				X			X							X					1	1		
24			X			X			X			X							X					2			
25																											
26																											
27																											
28																											
29																											

TABLE 1-5 COMPOSITE OF CAPSULE TEST REQUIREMENTS

PART 2 LOOP TEST REQUIREMENTS

TABLE 2-1 Maximum Estimated Requirements for Loop Tests

FIRMNESS	NUMBER OF TESTS TO BE PERFORMED DURING THE FOLLOWING TIME PERIODS												
	TOTAL	1960*		1961		1962		1963		1964		1965	
		1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
FIRM	1	1	0	0	0	0	0	0	0	0	0	0	0
LESS FIRM	310	14	32	32	35	29	24	26	24	24	23	24	23
SPECULATIVE	238	13	21	20	31	17	18	19	17	20	19	22	21
TOTAL	549	28	53	52	66	46	42	45	41	44	42	46	44

TABLE 2-2 Maximum Estimated Requirements for Loop Tests By Flux

AV'G FLUX X 10-14	NUMBER OF TESTS TO BE PERFORMED DURING THE FOLLOWING TIME PERIODS												
	TOTAL	1960		1961		1962		1963		1964		1965	
		1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Under 1													
FIRM	1	1	0	0	0	0	0	0	0	0	0	0	0
LESS FIRM	47	7	7	5	5	3	3	4	3	3	2	3	2
SPECULATIVE	71	12	15	14	17	4	2	2	1	1	1	1	1
TOTAL	119	20	22	19	22	7	5	6	4	4	3	4	3
1 to 2.5													
FIRM	0	0	0	0	0	0	0	0	0	0	0	0	0
LESS FIRM	137	0	10	11	13	14	13	14	12	13	12	13	12
SPECULATIVE	121	0	5	5	13	13	12	13	12	13	12	13	10
TOTAL	258	0	15	16	26	27	25	27	24	26	24	26	22
2.5 to 5													
FIRM	0	0	0	0	0	0	0	0	0	0	0	0	0
LESS FIRM	2	0	0	0	1	1	0	0	0	0	0	0	0
SPECULATIVE	43	1	1	1	1	2	3	4	3	6	5	8	8
TOTAL	45	1	1	1	2	3	3	4	3	6	5	8	8
Over 5													
FIRM	0	0	0	0	0	0	0	0	0	0	0	0	0
LESS FIRM	124	7	15	16	16	11	8	9	8	9	8	9	8
SPECULATIVE	3	0	0	0	0	0	0	0	0	1	0	1	1
TOTAL	127	7	15	16	16	11	8	9	8	10	8	10	9

*Calendar years are used throughout this report.

PART 2 LOOP TEST REQUIREMENTS

TABLE 2-3 Maximum Estimated Requirements for Loop Tests
By Diameter of Loop

INSIDE DIAMETER OF LOOP (INCHES)	NUMBER OF TESTS TO BE PERFORMED DURING THE FOLLOWING TIME PERIODS												
	TOTAL	1960		1961		1962		1963		1964		1965	
		1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Under 1													
FIRM	0	0	0	0	0	0	0	0	0	0	0	0	0
LESS FIRM	2	1	1	0	0	0	0	0	0	0	0	0	0
SPECULATIVE	85	0	3	3	7	7	9	9	8	10	9	10	10
TOTAL	87	1	4	3	7	7	9	9	8	10	9	10	10
1 to 2½													
FIRM	0	0	0	0	0	0	0	0	0	0	0	0	0
LESS FIRM	148	5	19	18	18	13	12	12	11	10	10	10	10
SPECULATIVE	111	13	18	15	20	7	4	4	4	6	6	8	6
TOTAL	259	18	37	33	38	20	16	16	15	16	16	18	16
Over 2½													
FIRM	1	1	0	0	0	0	0	0	0	0	0	0	0
LESS FIRM	160	8	12	14	17	16	12	14	13	14	13	14	13
SPECULATIVE	42	0	0	2	4	6	4	5	4	5	4	5	3
TOTAL	203	9	12	16	21	22	16	19	17	19	17	19	16

TABLE 2-4 Maximum Estimated Requirements for Loop Tests
By In-Core Length of Loop

IN-CORE LENGTH OF LOOP (FEET)	NUMBER OF TESTS TO BE PERFORMED DURING THE FOLLOWING TIME PERIODS												
	TOTAL	1960		1961		1962		1963		1964		1965	
		1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Under 4													
FIRM	1	1	0	0	0	0	0	0	0	0	0	0	0
LESS FIRM	33	4	9	7	8	3	1	1	0	0	0	0	0
SPECULATIVE	157	0	6	6	13	12	15	16	14	17	17	21	20
TOTAL	191	5	15	13	21	15	16	17	14	17	17	21	20
4 to 6													
FIRM	0	0	0	0	0	0	0	0	0	0	0	0	0
LESS FIRM	153	6	15	14	14	14	13	14	13	13	12	13	12
SPECULATIVE	75	13	15	13	16	4	2	2	3	3	2	2	0
TOTAL	228	19	30	27	30	18	15	16	16	16	14	15	12
Over 6													
FIRM	0	0	0	0	0	0	0	0	0	0	0	0	0
LESS FIRM	124	4	8	11	13	12	10	11	11	11	11	11	11
SPECULATIVE	6	0	0	1	2	2	1	0	0	0	0	0	0
TOTAL	130	4	8	12	15	14	11	11	11	11	11	11	11

TABLE 2-5

COMPOSITE OF LOOP TEST REQUIREMENTS

Item	CHARACTERISTICS OF TESTS																NUMBER OF TESTS WITH SPECIFIED CHARACTERISTICS TO BE INITIATED IN FOLLOWING TIME PERIODS:							
	Duration of tests (months)			Av'g. flux X 10^{-14}				Inside diameter of loop (inches)			In-core length of loop (feet)			Firmness of Requirements			1960		1961		1962	1963	1964	1965
	Under 6	6 to 12	Over 12	Under 1	1 to 2.5	2.5 to 5	Over 5	Under 1	1 to 2½	Over 2½	Under 4	4 to 6	Over 6	Firm	Less Firm	Speculative	1st half	2nd half	1st half	2nd half				
1	X			X						X	X			X			1							
2	X			X				X			X				X		1	1						
3	X			X					X		X				X		2	1	1					
4	X			X					X			X			X		3	2	1	1	2	2		
5	X			X						X	X				X		1	1						
6	X			X						X			X		X				1	2	4	5	5	5
7	X				X				X			X			X			10	10	10	20	20	20	20
8	X				X					X			X		X				1	2	4	5	5	5
9	X						X			X		X			X		3	3	3	3	5	5	5	5
10		X			X					X	X				X					1				
11		X				X			X		X				X					1				
12		X					X			X			X		X		3	3	3	3	3	3	3	3
13			X	X					X		X				X			2						
14			X		X				X		X				X						1			
15			X				X		X		X				X			4						
16			X				X			X			X		X		1	1	1	1	2	2	2	2
17	X			X					X			X				X	12	15	13	14	2	2	1	1
18	X			X						X	X					X				1	1	1	1	1
19	X				X			X			X					X				1	1	1	1	1
20	X				X				X		X					X		2	1	4	4	4	4	4
21	X					X			X		X					X					1	2	4	6
22	X					X			X			X				X	1							
23	X					X		X			X					X		1	1	1	1	1	1	1
24	X						X			X	X					X							1	2
25		X		X						X		X				X				1	1			
26		X		X						X			X			X			1					
27		X			X				X		X					X		1			1			
28		X			X				X			X				X				1			2	
29		X			X				X				X			X				1				
30		X			X					X		X				X						1		

30		X			X					X		X				X						1				

TABLE 2-5

COMPOSITE OF LOOP TEST REQUIREMENTS

Item	CHARACTERISTICS OF TESTS																NUMBER OF TESTS WITH SPECIFIED CHARACTERISTICS TO BE INITIATED IN FOLLOWING TIME PERIODS:							
	Duration of tests (months)			Av'g. flux X 10^{-14}				Inside diameter of loop (inches)			In-core length of loop (feet)			Firmness of Requirements			1960		1961		1962	1963	1964	1965
	Under 6	6 to 12	Over 12	Under 1	1 to 2.5	2.5 to 5	Over 5	Under 1	1 to 2½	Over 2½	Under 4	4 to 6	Over 6	Firm	Less Firm	Speculative	1st half	2nd half	1st half	2nd half				
1		X			X					X		X				X						1		
2		X				X		X			X					X					1	2	2	2
3		X				X				X	X					X					1	2	2	2
4		X				X				X			X			X					1			
5			X		X			X			X					X		2		3	5	5	5	5
6			X		X					X	X					X			1		1		1	
7																								
8																								
9																								
10																								
11																								
12																								
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PART 3: COMPARISON OF TEST FACILITY REQUIREMENTS WITH TYPICAL LARGE AND SMALL TEST REACTOR CAPACITIES

A small, 30-megawatt tank-in-pool test reactor and a large, 175-megawatt tank-type test reactor are used as bases for comparison. Insofar as irradiation facilities offered, both reactors are considered to be made up of modules each 3 by 3 inches in cross section with an effective length, 3 feet, roughly equivalent to that of the active core. Appendix A shows the irradiation capacities for the small and large reactors in both conventional designation and by modular concept. In both cases, the reactors may be considered as typical of present practice or "state of the art" are regards technical performance.

A. Capsule test comparisons

Table 1–1 indicates that the average requirement for capsule facilities during the survey period are 11 firm, 38 less firm, and 85 speculative.

Information concerning the distribution of capsule requirements according to length, diameter, flux, and type is presented in tables 1–2 through 1–4. The separate distributions of tables 1–2 through 1–4 were used to develop table 3–1 to give a composite average picture of capsule irradiation requirements.

Table 3–1 also includes a column to show the number of modules required to meet each capsule requirement. Four assumptions were used in converting from number of capsules to the number of modules:

1. Capsules up to 3 inches in diameter would require space equivalent in cross section (3 by 3 inches) to a single module.
2. Capsules over 3 inches in diameter would require space equivalent in cross section to two modules.
3. Only one instrumented capsule, regardless of length, could be accommodated in any one test hole.
4. Two noninstrumented capsules could be inserted in a single test hole since the fraction of such capsule over 12 inches in length is small, under 10 percent.

For comparison purposes, requirements grouped according to flux modules are shown in table 3–2 for firm, firm and less firm, and firm, less firm, and speculative capsules together with the capabilties of the large and small test reactors.

The following conclusions are drawn from table 3–2:

1. Either reactor could substantially meet all requirements in the firm category. This conclusion is strengthened by the fact that the firm requirement for loops is essentially zero and the loop space provided by the reactor could also be used for capsule irradiation.
2. The small reactor is more than adequate for requirements under 1 by 10^{-14} and can meet about one-third of the requirements in the 1 by 10^{-14} to 2.5 by 10^{-14} range in the firm and less-firm categories. It meets substantially none of the higher flux requirements.
3. The large reactor is more than adequate for requirements up to 2.5 by 10^{-14} in the firm and less-firm categories.

B. Loop test comparisons

Examination of table 2–1 indicates that the average requirement for loop facilities in the firm and less-firm categories is about 25 during the survey period. (The firm requirement is substantially zero.) Examination of table 2–3 indicates that the distribution by size for the 25 required facilities is roughly 50 percent greater than 2½ inches in diameter and 50 percent of diameter up to 2½ inches. Examination of table 2–2 indicates that the distribution by flux for the 25 facilities is roughly 15 percent or 4 loops under 1 by 10^{-14}, 44 percent or 11 loops in the range 1 by 10^{-14} to 2.5 by 10^{-14}, and 40 percent or 10 loops in the over 5 by 10^{-14} category. In this comparison, it is assumed that loops of less than 2½ inches in diameter can be accommodated in one module while four modules would be required on the average for loops that are more than 2½ inches in diameter.

Using information described above, industrial requirements for loop tests are converted to flux-module requirements as shown in table 3–3.

Table 3–4 compares loop requirements versus capacity of large and small test reactors. The calculations for the number of modules needed to accommodate total requirements are not shown. These calculations are similar to those used for firm and less firm requirements.

The following conclusions are drawn from table 3–4 (without regard to loop length):

1. Either reactor (30 or 175 megawatts) used for the comparison provides adequate capacity to meet firm and less-firm loop requirements for flux less than 1.0 by 10^{-14}.

2. The large reactor provides adequate capacity for firm and less-firm loop requirements for fluxes up to roughly 3 by 10^{-14}.

3. Neither reactor would meet a significant portion of the loop requirement in fluxes above 3 by 10^{-14}.

It should be noted that consideration was not given to loop lengths as listed in table 2–4 in comparing requirements with test reactor capabilities. The stated requirement for loops of less than 4 feet in length is small and the length distribution of firm and less-firm loops from table 2–4 is roughly 50 percent of length greater than 6 feet and 50 percent of length from 4 to 6 feet. Present experience is limited to active cores 3 feet in length, although cores up to 4 feet in length have been considered in conceptual designs.

To the extent that several loops of shorter length may be considered equivalent to a single longer loop, either the small or large test reactor used in the comparison can still meet a portion of the firm and less-firm requirements. A rough estimate on this basis would be that either the small or large test reactor could meet about 50 percent of the loop requirements below 1.0 by 10^{-14}, and that the large reactor might also meet 50 percent of such requirements in the 1.0 to 3 by 10^{-14} flux range. Neither reactor could meet a significant portion of the flux requirements above 3 by 10^{-14}.

It is probable that the equivalent suggested above would not apply in many cases and that the loop length specified would be that necessary in a single pressure tube for a valid test. In such cases, neither the small nor large test reactor postulated would be adequate.

TABLE 3-1

AVERAGE NUMBER OF CAPSULES UNDER IRRADIATION

	Instrumented				Non-Instrumented			
	No.	Diam. (Inches)	Flux x 10^{-14}	Modules	No.	Diam. (Inches)	Flux x 10^{-14}	Modules
FIRM	1	<3"	<1	1	2	<3"	<1	1
	2	<3"	1-2.5	2	4	<3"	1-2.5	2
	Small	<3"	>2.5		Small	<3"	>2.5	
	Small	>3"	<1		Small	>3"	<1	
	1	>3"	1-2.5	2	1	>3"	1-2.5	1
	Small	>3"	>2.5		Small	>3"	>2.5	
FIRM & LESS FIRM	4	<3"	<1	4	5	<3"	<1	2.5
	4	<3"	1-2.5	4	6	<3"	1-2.5	3.0
	3	<3"	2.5-5	3	4	<3"	2.5-5	2.0
	2	<3"	>5	2	3	<3"	>5	1.5
	2	>3"	<1	4	4	>3"	<1	4
	2	>3"	1-2.5	4	3	>3"	1-2.5	3
	2	>3"	2.5-5	4	2	>3"	2.5-5	2
	1	>3"	>5	2	2	>3"	>5	2
SPECULATIVE	12	<3"	<1	12	6	<3"	<1	3
	30	<3"	1-2.5	30	15	<3"	1-2.5	7.5
	5	<3"	2.5-5	5	3	<3"	2.5-5	1.5
	2	<3"	>5	2	1	<3"	>5	.5
	2	>3"	<1	4	1	>3"	<1	1
	4	>3"	1-2.5	8	2	>3"	1-2.5	2
	1	>3"	2.5-5	2	1	>3"	2.5-5	1
		>3"	>5			>3"	>5	

Note: <3" = 1 module
>3" = 2 module
Divide by 2 for non-instrumented capsules

TABLE 3-2

CAPSULE REQUIREMENTS VS TEST REACTOR CAPABILITY
BY FLUX-MODULES

Flux x 10^{-14}	Requirements			Capacity	
	Firm	Firm & Less Firm	Firm, Less Firm and Spec.	175 MW Reactor	30 MW Reactor
<1	2	15	35	94	35
1-2.5	7	14	62	26	5
2.5-5	Small	11	21		
>5	Small	8	10.		

TABLE 3-3

LOOP REQUIREMENTS - FIRM AND LESS FIRM

Distribution of Requirements By Size and Flux			Distribution of Requirements By Number of Modules and Flux	
Diameter	Number of Loops	Flux x 10^{-14}	Number of Modules	Flux x 10^{-14}
<2½"	2	<1	2	<1
<2½"	5	1-2.5	5	1-2.5
<2½"	5	>5	5	>5
>2½"	2	<1	8	<1
>2½"	6	1-2.5	24	1-2.5
>2½"	5	>5	20	>5

TABLE 3-4

LOOP REQUIREMENTS VS TEST REACTOR CAPABILITY
BY FLUX-MODULES

Flux x 10^{-14}	Requirements		Capacity	
	Firm & Less Firm Only	Firm, Less Firm and Specu.	175 MW Reactor	30 MW Reactor
<1	10	11	14	12
1-2.5	29	58	0	~3
2.5-5	0	10	27	
>5	25	26	~4	

IRRADIATION CAPABILITY FOR TYPICAL SMALL AND LARGE TEST REACTORS

30 MW Tank-In-Pool Test Reactor

Facility	Number Available	Average Thermal Flux x 10^{-14}
3" x 3" core loop	1	1.1
3" x 3" core loop	2	.9
3" up pool loop	4	.6
Capsule Facility	3	1.2
Capsule Facility	2	1.3
Capsule Facility	8	.8
Capsule Facility	27	.6

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Type of Space	Number of Modules	Average Thermal Flux x 10^{-14}
Loop	3	1.0
Loop	12	.6
Capsule	5	1.3
Capsule	8	.8
Capsule	27	.6

175 MW Tank Test Reactor

Facility	Number Available	Average Thermal Flux x 10^{-14}
9" x 9" core loop	1	2.9
6" x 9" core loop	1	2.7
6" x 6" core loop	3	2.9
3" x 3" core loop	4	4.8
6" x 6" reflector loop	2	.7
3" x 3" reflector loop	6	.9
Capsule Facility	94	.5
Capsule Facility	26	2.2

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Type of Space	Number of Modules	Average Thermal Flux x 10^{-14}
Loop	27	2.9
Loop	14	0.8
Loop	4	4.8
Capsule	94	.5
Capsule	26	2.2

APPENDIX B

AUGUST 27, 1959.

To: [The Company Addressed].
Subject: Need for Industrial Use of General Testing Reactors.

GENTLEMEN: General testing reactors constitute one of the vital resources in the development of atomic energy technology. These are reactors in which materials and components intended for ultimate use in nuclear power reactors can be subjected experimentally to conditions of temperature, stress, and irradiation similar to those which will exist in a power reactor. General testing reactors are large and expensive facilities which require several years to design and construct. In order to plan adequately for future testing facilities, it is, therefore, necessary to have well in advance of the actual need some indication of what future requirements for such facilities will be.

To help obtain the desired information, we are enclosing a questionnaire on which we ask you to state your known and estimated requirements for irradiation space. The questionnaire has been designed to impose as little burden as possible. To assist in the preparation of the form, separate instructions are enclosed. Please omit irradiations to be performed under Commission contract or in connection with cooperative arrangements with the Commission. If you do not anticipate having irradiation test requirements, we would appreciate having the form returned with this fact indicated.

Data regarding individual companies will be kept confidential. Public dissemination will be made only of the overall summaries of the separate items of information.

Please address your replies to the Director of Reactor Development, U.S. Atomic Energy Commission, Washington 25, D.C. We would appreciate receiving the completed questionnaire not later than September 18, 1959. Inquiries may be made to the above address, or, if by telephone, to Hazelwood 7-7800, Extension 5346.

Sincerely yours,

_____

(For Frank K. Pittman, Director, Division of Reactor Development).

INSTRUCTIONS FOR FORM AEC-487—ESTIMATED REQUIREMENTS FOR IRRADIATION SPACE

PART I—GENERAL INSTRUCTIONS

Purpose of form.—This questionnaire is intended to provide information on industrial irradiation testing requirements over the next 6 years. This information will be used within the Commission for guidance in developing plans to meet its unfilled irradiation test space requirements, particularly in the high flux range. The survey includes low flux requirements as well in order also to be of maximum interest and usefulness to industry.

What companies should state requirements.—Requirements should be stated by the organization which will determine the specifications and will have technical responsibility for the irradiation testing program. *Example:* Organization A has design, research, and development responsibility for a power reactor under contract to Organization B, which will own the reactor. As part of the necessary research and development, Organization A plans some test irradiations in Organization C's test reactor. The planned irradiations should be stated in Organization A's response on Form AEC-487, not in that of Organization B or C. Note particularly, however, that irradiations to be performed under Commission contract or in connection with cooperative arrangements with the Commission should not be reported.

Estimates.—Note that space is provided to indicate whether each requirement stated is firm, less firm, or speculative. One of the purposes of this is to encourage respondents to make estimates regarding commercial requirements which are not specific at this time but which, according to their best judgment, may develop before the end of 1965.

When and where returns should be filed.—Organizations receiving the questionnaire from AEC are asked to return one copy, *whether or not any requirements are stated*, by September 18, to the Director of Reactor Development, U.S. Attomic Energy Commission, Washington 25, D.C.

PART II—SPECIFIC INSTRUCTIONS

"Loops" and "capsules".—Note that loop tests are to be reported on one side of the questionnaire and capsule tests on the opposite side. Please fill out both sides, stating "None" on the appropriate side if no requirements are known or foreseen for either loop tests or capsule tests. A loop test is one in which the specimen to be irradiated is placed in a pressure tube located in or adjacent to the reactor core and through which a coolant at selected conditions of temperature, pressure, and flow rate may be circulated independently of the reactor coolant. A capsule test is one in which the sample to be irradiated is isolated from the reactor coolant by a sealed container. An "instrumented" capsule test is one in which the sealed container is provided with leads and instrumentation for measurement and control of experimental parameters.

"Characteristics of tests."—Note that the left-hand section on each side of the form requires merely that the respondent check one of several alternatives for duration, average flux, capsule or loop dimensions required, and firmness of requirements. More than one alternative should not be checked for any of these characteristics on any one line. Thus, if a respondent is reporting on two tests of identical duration, flux and dimensions, but one is considered "firm" and the other "speculative", two lines should be used, one for the "firm" test and the other for the "speculative" test.

"Duration of tests."—The number of calendar months the experiment will be in the testing reactor.

"Average flux X 10^{-14}."—The average *thermal* flux (neutrons per square centimeter per second) expressed in units of 10^{-14}. Respondents who have or envision experiments for which a *fast* flux is of paramount importance should list the requirement and call special attention to this fact.

"Firmness of requirements."—A "firm" requirement means one which has to do with a known testing requirement for a project which is underway. "Less firm" requirements are those which involve estimates of future tests for projects underway or for specific projects which are considered reasonably likely to develop. "Speculative" requirements refer to situations where the respondent does not have in mind a specific undertaking but judges from his appraisal of trends in the industry that one may develop.

"Number of tests to be initiated in time periods."—Whereas the left-hand sections of the form call only for check marks, this right-hand section calls for specific numbers to be inserted. These will represent estimates of the number of tests having the characteristics checked on a particular line which will be initiated in each of the time periods shown. Thus, if two tests with characteristics checked on line 2 are anticipated, one to be started in November 1960, the other in May 1962, the figure "1" would be inserted on line 2 under "1960 2d half" and under "1962", the other date columns being left blank. Please note that the time periods shown refer to calendar years, not fiscal years. Note also that where one line is used to describe several tests, the characteristics shown should be those of an individual test. *Example:* Three identical tests are each to be in the test reactor for 5 months making an aggregate of 15 months. Under "Duration of tests," the box for "Under 6 months" should be checked, not the box for "Over 12 months."

"Inside diameter of loop."—Means the useful, unobstructed diameter of test space inside the pressure tube.

"In core length of loop."—This refers to the useful, unobstructed length of the test space over which the specified average flux will apply inside the pressure tube. In practice, this length is limited by the length of the fuel section of the test reactors' fuel elements. In the design of test reactors the in-core length of loop required for anticipated loop experiments acts as a principal determinant of the height of the test reactor core.

"Diameter of holes."—Refers to the hole into which capsules will be inserted.

"Capsule length."—Self-explanatory.

Form AEC-487

ESTIMATED REQUIREMENTS FOR IRRADIATION SPACE - SIDE I. LOOPS*

Form Approved - Budget Bureau No. 38-5904

Name and address of responding organization:	Person to be contacted regarding this response:		Return 1 copy to:
	Name:	Title:	Director of Reactor Development U. S. Atomic Energy Commission Washington 25, D. C.
	Mailing Address:	Phone:	

CHARACTERISTICS OF TESTS (Check one alternative in each section)

Item	Duration of tests (months)			Av'g. flux X 10^{-14}				Inside diameter of loop (inches)			In-core length of loop (feet)			Firmness of Requirements			STATE NUMBER OF TESTS WITH SPECIFIED CHARACTERISTICS TO BE INITIATED IN FOLLOWING TIME PERIODS:							
																	1960		1961		1962	1963	1964	1965
	Under 6	6 to 12	Over 12	Under 1	1 to 2.5	2.5 to 5	Over 5	Under 1	1 to 2½	Over 2½	Under 4	4 to 6	Over 6	Firm	Less Firm	Speculative	1st half	2nd half	1st half	2nd half				
1																								
2																								
3																								
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* Use other side for capsule requirements

ESTIMATED REQUIREMENTS FOR IRRADIATION SPACE - SIDE II. CAPSULES*

Item	CHARACTERISTICS OF TESTS (Check One Alternative in Each Section)																		STATE NUMBER OF TESTS WITH SPECIFIED CHARACTERISTICS TO BE INITIATED IN FOLLOWING TIME PERIODS:							
	Duration of Tests (Months)			Av'g Flux X 10^{-14}				Diameter of Holes (Inches)			Capsule Length (Inches) Instrumented			Not Instr'd			Firmness of Requirements			1960		1961		1962	1963	1964	1965
	Under 6	6 to 12	Over 12	Under 1	1 to 2.5	2.5 to 5	Over 5	Under 1 1/8	1 1/8 to 3	Over 3	Under 6	6 to 12	Over 12	Under 6	6 to 12	Over 12	Firm	Less Firm	Speculative	1st Half	2nd Half	1st Half	2nd Half				
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* Use other side to state loop requirements. Signature _____ Title _____ Date _____

Representative VAN ZANDT. At this point, Mr. McCone, can you give us a rundown on what is going on in the field of advance test reactors?

Are you using all of the time of the existing test reactors?

Mr. MCCONE. Yes, Mr. Van Zandt. The MTR and the ETR are used fully. The forecast is that we will have requirements beyond their capacity, and for that reason we have been actively negotiating for the construction of an intermediate flux reactor on which Babcock & Wilcox presented the low bid. These negotiations have not been completed. I am reasonably hopeful that the differences will be overcome.

In the meantime, we have contracted for some space in the General Electric reactor and are negotiating for space in the Westinghouse test reactor.

Representative DURHAM. Is this going to be primarily for metallurgical work?

Mr. MCCONE. Metallurgical work and fuel elements primarily.

Representative VAN ZANDT. Now, Mr. McCone, are we using any time in the Canadian test reactor?

Mr. MCCONE. Yes, we are using time there.

Representative VAN ZANDT. Did I understand you to say there was surplus time at GE and other privately owned reactors?

Mr. MCCONE. There has been up to recently.

I would like to ask Dr. Pittman what the current status is.

Dr. PITTMAN. The current status is that we are putting the loops and capsules into the GE test reactor. There is still space available in that reactor.

Representative VAN ZANDT. When did you install these new loops and so forth?

Dr. PITTMAN. They have been going in over the last few months, sir. I don't know when the first one went in. It was during the fall. I think the first one probably went in the General Electric reactor. We are still attempting to negotiate a contract with the Westinghouse group. They are raising the power level of their reactor and it should be ready for operation about April, I believe.

Representative VAN ZANDT. Then is it proper for me to assume, Dr. Pittman, that the surplus time of Westinghouse and GE test reactors is gradually being absorbed by the AEC?

Dr. PITTMAN. The time of the Westinghouse and GE reactors is or will be gradually taken up by the AEC over the next year or 18 months. I do not think we have requirements to fill those reactors completely, sir.

Representative VAN ZANDT. How long will it take to build this proposed $24 million test reactor?

Dr. PITTMAN. That would take about 2 to 2½ years.

Mr. MCCONE. I would like to indicate that maybe with the design time and so forth it might be a little longer. The actual construction I believe would take 2½ years, but 6 months to a year might be involved in developing a really satisfactory design.

Representative VAN ZANDT. Then as I see it, the AEC will use its facilities to capacity and will depend somewhat on the Canadian as well as the Westinghouse and General Electric reactors. Speaking of other than Government facilities, will they be adequate to meet the

needs of the AEC for the next several years or until this new test reactor is completed?

Mr. McCone. Yes, we think so.

I would like to emphasize that this $24 million project is a high-flux reactor. It is much higher than anything we have now.

Representative Durham. Mr. Chairman, I think the Joint Committee staff has made a study of test reactors since the beginning of this program.

Before we adjourn, if there is no objection, I think this ought to go into the record.

Representative Holifield. Without objection, it will be received in the record.

It is a study that the staff has made on this whole program.

(Information referred to follows:)

History of Test Reactors

November 7, 1956.—The Acting General Manager, by letter to Chairman Anderson, stated that the Commission has adopted a policy of fostering the construction by private industry of test reactors for general use through assurances to industry that—

(*a*) The AEC will construct test reactors only if its needs for irradiation space cannot be met by private industry under contracts reserving for Government use a percentage of the space available in privately owned test reactors and

(*b*) The AEC will permit the use of AEC-owned test reactors, for non-governmental purposes, only if privately owned facilities are not available for the irradiation services required.

Letter also stated the judgment of the Commission that a substantial number of new test reactors would be required in addition to the MTR and ETR. The willingness of private industry to construct test reactors was stated as deterred because of fear of Government competition, belief on the part of Government contractors that the Government would provide all necessary test reactors, and the difficulties of obtaining firm commitments for use of a reasonable amount of test reactor space.

The letter continued: "Until private industry is ready to finance the design, development, construction, and operation of test reactors of advanced design, the Commission's policy envisages a continued Government role in the field."

It was stated that at a later date an invitation for proposals for furnishing irradiation services would be issued. (The public announcement stating the AEC policy was issued the following day, Nov. 8, 1956.)

February 19, 1957.—"202" hearings, page 121: The AEC opening statement included the statement that "the need for test reactor capacity is increasing rapidly."

February 20, 1957.—"202" hearings, page 413: The Yankee Atomic Electric Co. stated in a letter to Chairman Durham: "The present difficulty of obtaining space and in-pile irradiation time in the materials testing reactor and engineering test reactor is already critical, and the rapidly increasing needs for such facility will not be wholly met by the additional test reactors currently under construction by the Commission [sic] and certain major industrial concerns. It appears that this is an area where limited expenditures may well achieve very significant results in removing a little publicized bottleneck in the overall national program."

February 27, 1957.—"202" hearings pages 513–514: Jerome Luntz, editor of Nucleonics, "There is virtually a complete absence of high-flux testing reactors in Western Europe." Mr. Luntz suggested construction of a large test reactor in the United States for exclusive use of foreign countries, with private groups to be canvassed first before such a project would be undertaken by the Government.

April 2, 1957.—Comptroller General decision re limiting AEC's authority to contract for more than 1-year period for the furnishing of supplies or services.

April 10, 1957.—In the authorization hearings held in 1957, pages 57 and 113, AEC informed the Joint Committee that a fuel element test reactor at an

estimated cost of $17.5 million was requested from the Bureau of the Budget but was not contained in the request before the Congress.

November 21, 1957.—Joint Committee's seminar with reactor experts contained a conclusion that more "research and testing reactors (similar to MTR and ETR) need be built by the Government. We cannot depend entirely upon private industry to build and support research and test facilities. This includes hot cells and supporting equipment." (Summary contained in "AEC Authorization Hearings for Fiscal Year 1959," held in May and June of 1958, p. 208.)

"Industry often has excess capacity in its own facilities, but competitive considerations have a tendency in some instances to discourage the use of one firm's facilities by another."

December 1957.—Commissioner Vance stated on June 4, 1958, in the authorization hearings, page 240, that in industry meeting held in December of 1957 there was "unanimous agreement * * * that we needed more test facilities."

June 4, 1958.—During the authorization hearings held in 1958, pages 236 and 237, during discussions of AEC and industry use of test reactors, Mr. Holifield stated that the Bureau of the Budget had refused an AEC request for $35 million for materials and engineering test reactors and instead allowed $27.5 million for rental. Mr. McCarthy of AEC agreed this was correct.

Mr. Holifield also stated that "rentals would be spent in the main with universities and nonprofit institutions rather than with private profit enterprises." Commissioner Vance agreed with this statement.

Mr. Davis of AEC said that quite a number of companies were interested in proposing test reactors and "our studies of the necessity for space in test reactors have shown that there is now and will be for quite a period in the future quite a demand for space. The problem is that companies who are interested in building these reactors, although they can see the demand, cannot get anybody to sign up and say they are willing to contract for it now."

Mr. Holifield said if AEC has to build the test reactor another year would be lost due to the need for future authorization and appropriation. Commissioner Vance agreed with this statement.

June 11, 1958.—Authorization hearings, pages 358–361: Mr. Freeman, of the General Electric Co., stated that the GETR was scheduled for regular operation in December 1958. He stated that AEC authority for long-term commitments would in his opinion remove a major roadblock to construction of privately financed test reactors. He also stated that GE's prime reason for building the GETR was for its own work, with not over 25 percent of the capacity required by GE's own programs. "In spite of the reported critical shortage of test reactor capactiy there is not at this moment a single firm commitment from the AEC or its contractors for the use of this test reactor." He concluded that "Experience in seeking commitments for the service of GETR raises a question as to the reality of the reported shortage of test reactor capacity."

August 19, 1958.—Public Law No. 85–681 was approved containing a new subsection 161u to the Atomic Energy Act, giving AEC authority to make long term contracts for reactor space rental.

October 1, 1958.—Letter from the General Manager of AEC to Chairman Durham advising that the Commission had invited proposals to furnish irradiation services in test reactors to be constructed and operated by industrial concerns, research organizations, or educational institutions. (The invitation was actually issued on October 2, 1958.)

The letter stated that the invitation was to obtain services in addition to those available in the MTR and the ETR. "Additional space is required for all phases of the reactor development program and is particularly important to the fuel cycle development program which is being initiated in the current fiscal year. This program directed toward the development of new reactor fuels and fuel processes will, to a large degree, be dependent upon the availability of space in test reactors." The invitation stated that "No more than 50 percent of the space specified will be procured from a single supplier."

January 19, 1959.—Letter from General Manager to Chairman Durham containing copy of press release stating that 11 proposals have been received by AEC for test reactors. "Requirements of industry and other government agencies for space in test reactors are expected to increase significantly over the next several years. To assure the availability of testing space and thus reduce the demands on the Commission for such space, the Commission will

give consideration to the extent to which proposers will make irradiation space available to non-Commission users."

February 27, 1959.—The authorization hearings held in 1959, pages 179 to 180 and 187. Project 60–e–3. Alterations, modifications and additions to MTR–ETR utility, technical and support installations: AEC requested $4.5 million from the Bureau of the Budget. The request to Congress was $2 million. Dr. Pittman stated the big difference was $1.5 million for the cost of increasing the power in the MTR from 40 to 60 megawatts.

February 27, 1959.—Authorization hearings held in 1959, page 188: Dr. Pittman stated that at present not enough business existed to keep the ETR, MTR, GETR, and WTR filled. He also stated that in the future there would be AEC requirements which could not be met in those four reactors. When asked by Mr. Holifield why Government reactors were loaded to capacity and private reactors were not being used, Dr. Pittman could not answer.

March 23, 1959.—During the authorization hearings, page 239, General Luedecke said re proposals on test reactors: "We expect to make our recommendations to the Commission before mid-April on the entire program."

Dr. Pittman said: "* * * one of the things that can become limiting is if we do not carefully plan the availibilty of test space for the proper size and flux."

July 24, 1959.—Letter from General Manager to Chairman Anderson concerning press release of the same date stating that AEC had selected the Babcock & Wilcox proposal as the basis for contract negotiations. Construction of the proposed reactor was estimated to take 2 years. None of the proposals met the high flux requirements and AEC was initiating a design study and would discuss with industry and other interested parties the extent to which private reactors might meet the high flux requirements.

The General Manager's letter added that of the 11 proposals received by AEC 2 had been withdrawn and 8 were not accepted by AEC. The letter also stated that the industry meeting with regard to the high flux requirements were to determine if private reactors could meet the need or if AEC would need to build at an AEC site.

August 1, 1959.—The memorandum discusses industrial testing reactors efforts to contract with AEC for testing reactor. (Information received from AEC indicated that the industrial testing reactor proposal was not accepted in addition to the Babcock & Wilcox proposal because the annual cost to AEC was less by using WTR and GETR.

September 9, 1959.—General Manager to Chairman Anderson transmitting advanced copy of September 11, 1959, press release stating that AEC was conducting a survey of industry requirements for high-flux irradiation space in test reactors. The letter states: "As you know, the Commission's requirements for high-flux irradiation space are in excess of present and planned capacity. In considering appropriate action to satisfy these requirements, the Commission determined that such action should also take into account industry's requirements for irradiation space in excess of present and planned capacity."

September 16, 1959.—Press release by AEC stating that AEC had authorized a conceptual design of a high-flux test reactor by Phillips Petroleum Co.

October 2, 1959.—Letter to Dr. Pittman, AEC, from Industrial Testing Reactors, Inc., stating: "I guess maybe we are bears for punishment but we have so much invested in this business already that we felt, perhaps, we should see the thing through." In letter ITR asked to be put on the list to be issued a new invitation to construct a high-flux testing reactor.

October 15, 1959.—Pittman wrote Republic Aviation re high-flux needs: "It is still our intent to discuss with industry how these needs may be met in privately owned reactors. In preparation for the discussions we are presently untertaking an intensive review and reevaluation projected Commission requirements."

December 28, 1959.—On a visit to GETR, Congressman Van Zandt and Commander Bauser were told by a representative of GE that only a portion of the irradiation capacity was used and that GE was sustaining losses on the GETR operation. The GE representative also stated that negotiations with AEC had been in progress for about 6 months but that no additional irradiation work had yet been obtained from the Government.

The manager of AEC's San Francisco Operations Office stated that GE was requesting a 5-year amortization life which Shute said was a controversial item in the AEC–GE negotiations.

February 12, 1960.—$24.0 million for a high-flux test reactor was included in AEC's fiscal year 1961 authorization request.

February 18, 1960.—Francis K. McCune, vice president, General Electric Co., testified at "202" hearings as follows:

"The lack of sufficient load for our test reactor has continued to be a major problem for General Electric.

"Two years of intensive effort to sell (test reactor) space has indicated to us that the demand is not nearly as great as has frequently been assumed."

February 19, 1960.—John J. Ryan of Republic Aviation at "202" hearings stated Republic, Minnesota Mining & Manufacturing, and Allis-Chalmers have made a proposal to AEC to furnish high-flux irradiation service, and are still very interested, whether on industry financed and operated or Government financed and industry operated basis.

Representative HOLIFIELD. While we are on this $24 million advance test high-flux reactor, did the AEC make a solicitation on this matter heretofore?

Mr. MCCONE. Solicitation to industry?

Representative HOLIFIELD. Yes.

Mr. MCCONE. We had some discussions with industry during the fall. Those discussions indicated that there was no commercial need for the services of a high-flux reactor. While some industries indicated some interest in building and operating a reactor, since the whole use of it would be for the AEC it didn't seem that it would be a fruitful negotiation.

Representative HOLIFIELD. Does this have to do with the Navy program?

Mr. MCCONE. This has to do with the Navy program.

Representative HOLIFIELD. Will it be ready in time for the Navy to use it for the program they planned it for, or is it a continuing tool?

Mr. MCCONE. It is a continuing test tool in connection with the long-range fuel element improvement program.

Representative DURHAM. It is also useful in the field of missiles; is it not?

Mr. MCCONE. I would think that they would find a use for that, yes. I think the primary use, however, for this facility is for the Navy reactor program.

Representative DURHAM. There is not any reason in the world why this basic research is not coordinated in all fields of metallurgical testing, which is one of the things that we face with regard to where we go, because of the fact that temperatures required are so high and there are not materials available to take care of them.

Mr. MCCONE. That is right.

To the extent that materials for any agency or any activity require study of physical characteristics and conditions of irradiation and high temperatures, this will be a very useful facility.

Representative HOLIFIELD. The backup material shows that this was needed mostly for the Navy program.

Mr. MCCONE. That is right.

Representative HOLIFIELD. I wonder if the delay which has occurred as the result of these solicitations has held up the Navy program?

Mr. MCCONE. I don't think so.

Representative HOLIFIELD. You have had the requirement quite a while; have you not?

Dr. PITTMAN. Sir, you can use lower flux reactors to meet the requirements. It just takes a longer time to get the information. So the Navy has been using the available space in the existing reactors and in the Chalk River reactor, which is a reasonably high flux

reactor. Therefore, it is not a question of not doing something. It is just a question of taking considerably longer to do the experimental program.

This reactor has and is being developed very carefully with the Navy. We are working very closely with Admiral Rickover's people to be sure that what we build will meet their requirements as nearly as it is possible to meet such requirements. But it is not a question of space. The work has been going on and I would say it has not been held up.

Representative HOLIFIELD. Does the AEC intend to start building this or will there be a further delay?

Mr. MCCONE. We intend to build it right away.

Representative DURHAM. This is new work far beyond anything that exists today; is that correct?

Mr. MCCONE. That is right.

Representative VAN ZANDT. For my own information, would it be possible to convert these existing test reactors to the high-flux field?

Mr. MCCONE. No, I do not think so. You can increase the flux somewhat, but you cannot get to the flux that is anticipated.

Representative VAN ZANDT. In other words, it is necessary to build a new reactor?

Mr. MCCONE. Yes.

Representative VAN ZANDT. Doctor, spell out this time factor you mentioned a moment ago about the Navy.

Dr. PITTMAN. All I am saying, sir, is when you are testing a fuel element in a test reactor, the speed with which you can get the results depends upon the number of neutrons that go in in a given time. The number of neutrons that go in are dependent on the flux. If the flux is 10 times higher than the one you have available, you can carry out the radiation considerably quicker.

Representative VAN ZANDT. Is it proper to say that the Navy could get results in 1 year what it would get from 3 years using the ordinary type test reactor?

Dr. PITTMAN. You mean the new reactor?

Representative VAN ZANDT. Yes.

Dr. PITTMAN. It is that order of magnitude.

I would rather not say definitely. It is of the order of 3 to 5.

Representative DURHAM. You may proceed.

PHYSICAL RESEARCH PROGRAM

Mr. MCCONE. Physical research projects: The largest physical research project proposed for authorization is the $12 million high-flux isotope reactor for construction at the Oak Ridge National Laboratory. This facility will have a key role in the Commission plans for the production of transuranic elements for research.

Three projects totaling $3,600,000 are planned for the Brookhaven National Laboratory; namely, a bubble chamber house to be constructed in conjunction with the alternation gradient synchrotron, additions and changes to the research reactor and accelerators at Brookhaven, and an extension to the metallurgy building.

For the Lawrence Laboratory, three projects are planned, totaling $2,550,000. These would provide additional shielding required in operation of the bevatron, modifications to the bevatron and other

major accelerators at Berkeley, and an increase in the space available for experiments using the 184-inch cyclotron.

Finally, construction of a new wing and a storage building for the Princeton-Pennsylvania accelerator is proposed at an estimated cost of $1,350,000.

Representative HOSMER. Mr. Chairman, I would like to ask Mr. McCone, most of this transuranium work has been done at Berkeley, so why is the $12 million high-flux isotope reactor being planned for Oak Ridge?

Mr. MCCONE. We feel that the Oak Ridge National Laboratory is a logical location for this particular reactor. A great deal of work has been done in this area at Oak Ridge. It has been an area of particular interest to Dr. Weinberg.

Representative HOSMER. At Brookhaven they had a very serious problem respecting a new chemical building, as I recall. Has that been taken care of?

Dr. MCDANIEL. There is no item in the budget for the Brookhaven chemistry building.

Representative HOSMER. That is the same situation we have had in the past 3 or 4 years, is it not? There has been agitation for that building, has there not?

Dr. MCDANIEL. They would like to have it; yes.

Representative HOSMER. Also, in connection with the bubble chamber house to be constructed at the synchrotron at Brookhaven, how about the bubble chamber itself?

Dr. MCDANIEL. The bubble chamber itself comes out of operating funds and is being built now.

Representative HOSMER. At Berkeley, when they put the bubble chambers in there, they ran across the problem of space for doing their photographic development and analysis work. Are we going to run across that at Brookhaven?

Dr. MCDANIEL. It is impossible, as the years go on, we will have a problem like that, although at the moment we do not know about it.

Representative HOSMER. When is this bubble chamber going to be finished? It will be a year or two.

Dr. MCDANIEL. It will be 2 years. Fourth quarter of fiscal year 1962.

Representative HOSMER. Then you start running experiments and taking photographs. Then they will have to be analyzed and so on.

Are there physical facilities in which that work can be done?

Dr. MCDANIEL. Initially, yes; and certainly for the foreseeable future, yes.

Mr. MCCONE. There are very substantial additions to the Lawrence Radiation Laboratory and the bevatron that have been indicated to us as essential. We have included in the 1961 budget those things we thought that must be started now to permit the orderly development of that Laboratory.

Representative HOSMER. That is what I wanted to ask you about next, Mr. McCone. We will get into the shielding first. You have asked $1.1 million for the shielding. As I understand, in your support material, you say that the present pulse level of the bevatron is either 10^{11} protons or 2×10^{11} protons. I cannot tell from your backup material on page 32 but I assume it is 2×10^{11}; is it not?

Dr. McDaniel. That is correct.

Representative Hosmer. The $1.1 million, you say, will take care of the inadequacies of shielding at this pulse level in certain parts of the lab building. The job is also to include foundation and support structure work for the additional shielding when the power is increased, is that right?

Mr. McCone. That is correct.

Representative Hosmer. How much will that additional shielding come to in terms of money?

Mr. McCone. I would like to get that figure for the record.

Representative Hosmer. Is $200,000 about right?

Dr. McDaniel. It is $300,000.

Representative Hosmer. So that is all you need to build up and complete the shielding job for increasing the power there approximately 100 times.

Mr. McCone. Yes. That can be done at the time the power is to be increased.

Representative Hosmer. In your backup material you say there is recognized the necessity to increase the power. Am I correct in saying that will cost about $9 million?

Mr. McCone. The entire improvements of the bevatron are $10 million.

Representative Hosmer. When in the future would you foresee the commencement of that work?

Dr. McDaniel. The Laboratory itself would like to obligate it through 1965 on a schedule as follows: $2.8 million in 1961, $3.4 million in 1962, $1.7 million in 1963, $600,000 in 1964, and about $500,000 in fiscal year 1965.

Representative Hosmer. Will you repeat that? When was the first time that they wanted to spend money on this?

Dr. McDaniel. 1961.

Representative Hosmer. $3 million?

Dr. McDaniel. $2.8 million is the figure that has been given to me. In 1962, $3.4 million.

Representative Hosmer. Does not the AEC Research Committee also recommend that this work be commenced on that time schedule?

Dr. McDaniel. I am certain it is not on the same time schedule because these data have just been handed to me.

Representative Hosmer. What are your present thoughts regarding a time schedule?

Dr. McDaniel. We have in the budget an item of $1.1 million for the shielding.

Representative Hosmer. I am talking about increasing power. You were just giving me increase of power figures. Let us not try to confuse the issue here.

Dr. McDaniel. Even if we do not go to the increased power, the $1.1 million is absolutely necessary for this year.

Representative Hosmer. I understand that, sir. I am asking you since you have disregarded the recommendations of the laboratory and the advisory committee, what do you have in mind as to a date to start this work on. How many years in the future are we going to wait before we get to it?

Mr. McCone. I would like to explain to the committee just what our position is on this whole high energy accelerator program. The

situation here is that we have several machines under construction. Each of the machines was presented to the committee at a very modest cost and at quite a low annual operating cost. With the development of this science, it appears that the machines will cost very much more than was originally anticipated. Two and a half or three times as much. The operating costs will be higher than expected by maybe four or five times as much. As I recall the figure, it runs from an original estimate of $13 million a year up to something of the order of $65 million or $70 million a year. The Commission has reviewed this entire program. We have analyzed what is necessary to develop the machine so it can be called in the light of known technology a fully developed machine, and the operating cost to operate that machine consonant with what might be termed the reasonable utilization of a facility.

What has to be determined is whether this is an agreed level of effort in this field. It runs into a very large bill, as you know.

If you add in the Stanford accelerator which we are not now prepared to talk about to this committee, but will be shortly, you will have a total investment in high energy accelerators of $250 million to $300 million, and annual operating cost on the order of $125 million for the six machines together with the other work being done in universities in high energy physics. This is a very major effort. What I want is everyone to understand that is where we are going. If this is recognized by not only the scientists as desirable but by the Commission and by the administration and by those responsible for the overall budget, and so forth, then this is a good thing to do. But what I do not want to do, Mr. Hosmer, is to see us go forward to this high level and then find that the only way we can fund it is by taking money away from other essential areas of research.

Representative HOSMER. I understand that. You are trying to explain the same situation that Admiral Rickover did the other day when he was talking about Pope Pius' difficulty with his architect.

Mr. MCCONE. It is a little different because while some of this additional cost is due to overruns of a type that Admiral Rickover and his architect had to explain to Pope Pius II, nevertheless many of these additional costs are due to the fact that this science has advanced considerably in the last 5 years and means of utilizing these machines have developed which were not thought of when the machines were first considered in 1955 or 1954 or whenever it was.

Representative HOSMER. That is an exellent point. But rather than get into the whole field I do want to question you a little more with respect to the work at Berkeley and ascertain whether or not $3 or $4 or $5 million here would not be a wise expenditure.

Let me put it this way: Have there been any discoveries of transuranium elements at any place other than Berkeley?

Dr. MCDANIEL. No.

Representative HOSMER. There have not been. The Berkeley Laboratory has a worldwide reputation in this field, does it not?

Dr. MCDANIEL. It certainly does; yes.

Representative HOSMER. That reputation is directly connected, if you want to use the expression, with our international prestige in physics; is that right?

Mr. MCCONE. There is no question about that.

Representative HOSMER. As I understand it, there have been two international conferences on high energy physics, one in Geneva in 1958 and one in Kiev in 1959. At both of those meetings, approximately 75 percent of the papers came out of work done at Berkeley; is that correct?

Dr. MCDANIEL. I doubt that those figures are exactly true for Berkeley but a large percentage of the U.S. papers came out of Berkeley; yes.

Representative HOSMER. Is it not a fact that much of the work that is done in the laboratories of other universities around the country depends upon the work that is done by the Bevatron?

Dr. MCDANIEL. Yes, and the work that is done at Brookhaven, at Rochester, and other places.

Representative HOSMER. What would happen if the next transuranium element comes out of a laboratory in the U.S.S.R. in relation to our reputation in this field?

Dr. MCDANIEL. I suppose the Soviet Union would get some credit for discovering it and our prestige would go down some. I don't think it would be a world-shaking event if the Russians happened to discover something before we did.

Representative HOSMER. Is it not a fact, however, that today the Berkeley Laboratory is in terms of high energy physics the mecca of the world scientists who are working in this field?

Dr. MCDANIEL. It is one of the leading institutions, yes, sir, but I would not call it a mecca. Brookhaven deserves a good deal of credit. The European laboratory at Cern deserves a great deal of credit. It is true that Berkeley is a place where leading scientists wish to work.

Representative HOSMER. And they have come and they have worked there?

Dr. MCDANIEL. Yes.

Representative HOSMER. This work on the Bevatron that we have talked about increasing its power, as you have read from your figures there, needs roughly $3 million in 1961, $3 million in 1962, and possibly $2 million in 1963, and a half million dollars for a couple of years after that.

Dr. MCDANIEL. Those were the estimates which the laboratory itself felt it needed and could use; yes.

Representative HOSMER. Each year that the commencement of this appropriation of $3 million is delayed, delays the increasing of the power of the Bevatron by 1 year; does it not?

Dr. MCDANIEL. Yes.

Representative HOSMER. It thereby delays whatever discoveries may come from that machine by a similar period?

Dr. MCDANIEL. Such discoveries that may be dependent on the increased power, yes.

Representative HOSMER. That is right. As a matter of fact, the type of experimentation that we are looking forward to now is a great deal more complex than has been done on that machine in the past; is that correct?

Dr. MCDANIEL. This is true of all the machines and I think that is one of the reasons for the increased cost that Mr. McCone spoke about.

Representative HOSMER. It also requires increased power?

Dr. MCDANIEL. Yes.

Representative HOSMER. In other words, most of the simple experiments have been done; is that right?

Dr. MCDANIEL. A good many of them have been done, but some of the experiments that are remaining are relatively simple. It is true that in the high energy physics field it is becoming more and more complex to do experiments. It is still possible to do relatively simple experiments in science.

Representative HOSMER. Your scientific advisory committee has at least expressed the opinion that starting this work now would be timely and somewhat of a bargain for the United States in this particular field, has it not?

Mr. MCCONE. What committee is this?

Representative HOSMER. Your scientific advisory committee, the General Advisory Committee.

Dr. MCDANIEL. No, our General Advisory Committee, as such, has not made such a recommendation, no. A subcommittee of the General Advisory Committee and the President's Scientific Advisory Committee has made two reports which have been submitted to your committee, commonly referred to as the Piore report. That committee has recommended several things, the first three being the completion of the existing facilities or plants under construction, with such additions as will appear to be desirable.

Second, the operation of those units at a level consonant with what might be considered full utilization.

Third, the construction of the Stanford accelerator.

Representative HOSMER. Wait a minute. You are not even operating those things at full utilization; is that correct?

Dr. MCDANIEL. That is correct.

Representative HOSMER. Under the amount of operating funds that have been recommended in the $14 million. Did the laboratory request $16 million?

Dr. MCDANIEL. Yes; I think so.

Representative HOSMER. Did they say that they could not carry on at full level without at least a million dollars more?

Dr. MCDANIEL. I think there was a difference of opinion between the Commission and the Commission staff and the laboratory in this regard.

Representative HOSMER. Your research division made a recommendation with respect to these bevatron improvements; did it not?

Dr. MCDANIEL. Yes.

Representative HOSMER. Did it not recommend the authorization of $11.2 million and the funding of $4.2 million?

Dr. MCDANIEL. Yes.

Representative HOSMER. Is this a competent group?

Dr. MCDANIEL. I would prefer someone else answer that.

Mr. MCCONE. Yes, very competent.

Representative HOSMER. That is all, Mr. Chairman.

Representative DURHAM. You may proceed.

Dr. MCDANIEL. I would like to point out that there is an additional item in the budget for the bevatron and accelerators at Berkeley. It is an item of $950,000.

Representative HOSMER. Yes. That does not add up with the $1.1 million?

Dr. McDaniel. It is a separate and entirely different item. It is for general improvements of all the accelerators at Berkeley.

Representative Hosmer. Those are minor improvements. You cannot do very much with $950,000 in this machinery.

Mr. McCone. That is right.

Representative Hosmer. As long as we brought that up, there is one thing we did not clear up. You say you are planning a total of $2,550,000 and that $1.1 million and $950,000 does not add up to that sum for Berkeley. What else is in there?

Mr. McCone. There are three projects.

Representative Hosmer. We have the accelerator improvements at $950,000.

Dr. McDaniel. The bevatron shielding at $1.1 million.

Representative Hosmer. That only adds up to less than that. Is that $2,550,000 now correct?

Mr. McCarthy. Project 61-g-2, the addition to the cyclotron building, is an additional item.

Representative Hosmer. I missed that one. Thank you. $500,000, yes.

BIOLOGY AND MEDICINE PROGRAM

Mr. McCone. Biology and medicine projects: For the biology and medicine program, $4 million is proposed to accommodate the requirements of our laboratories and university contractors for various biomedical facilities. Typically, such facilities are needed to enlarge investigations of the effects of radiation on biological systems and the hazards associated with radioactive fallout and other atomic energy operations.

Representative Durham. How does this compare with the request in the budget for 1960?

Mr. McCone. I do not have that figure readily available. I have been informed it is just the same.

Representative Durham. The same as it was last year?

Mr. McCone. Yes, sir.

Representative Durham. Thank you.

(Note.—$3 million was authorized last year, as indicated in testimony of March 10, 1960, by project 60-h-1.)

COMMUNITY PROGRAM

Mr. McCone. Community projects: Three community projects for Los Alamos totaling $715,000 are concerned with the development of additional real estate on Barranca Mesa, construction of an elementary school addition, and construction of a steam transmission line.

GENERAL PLANT

General plant projects: Authorization of $34,175,000 is requested for general plant projects. From this amount would be provided the miscellaneous minor additions, expansions, and other new construction which experience has shown are required each year to assure the adequacy and efficiency of our physical plant and laboratory facilities, which today represent an investment of more than $7 billion.

COMMUNITY PROGRAM

Senator HICKENLOOPER. Mr. Chairman, getting back to the item of community projects, $715,000, you state that they are concerned with the development of additional real estate on Barranca Mesa, construction of an elementary school addition and construction of a steam transmission line. Is that three items, and if so, what is the development of additional real estate on the Barranca Mesa? What does that mean?

Mr. MCCONE. Barranca Mesa is an area in which we are developing the real estate and selling the property to individuals to construct private housing. This project provides for the general opening up of the property, as you must do with any newly opened subdivision.

Senator HICKENLOOPER. Is the Government reimbursed for that? Does it sell it and get its money back?

Mr. MCCONE. We do sell the lot, yes. Whether this is fully recoverable or not I do not know.

Mr. LUEDECKE. It is not normally fully recoverable by the sale of the lot, but the return from the utilities over a period of years does fully reimburse.

Senator HICKENLOOPER. You mean the return for the payment of water, electricity, and gas and things like that?

Mr. MCCONE. Yes, sir.

Senator HICKENLOOPER. That will reimburse the Government fully for the real estate development there?

Mr. MCCONE. That is right, sir.

Senator HICKENLOOPER. How much of the $715,000 will go into the development of Barranca Mesa?

Mr. MCCONE. Of this $715,000, $435,000 is for this purpose.

Senator HICKENLOOPER. And the rest of it goes for the construction of an elementary school and of a steam transmission line?

Mr. MCCONE. $145,000 is for construction of the addition to the elementary school and $135,000 is for the addition of a steam line.

INCREASE IN PERSONNEL AT LOS ALAMOS

Representative DURHAM. Has the personnel at Los Alamos increased in the last 12 or 18 months?

Mr. LUEDECKE. I would like to ask General Starbird to speak to that question.

General STARBIRD. I missed the question, Mr. Durham.

Representative DURHAM. Has the personnel increased at Los Alamos?

General STARBIRD. No, sir. The personnel at Los Alamos has not increased recently. It has remained relatively stable. However, there is a situation there where we cannot house at Los Alamos in the Government housing all of the personnel who are employed at the laboratory and in related activities. This program is one to attempt to have additional housing developed in the area, the housing to be paid for by the residents who cannot get housing or cannot get satisfactory housing now, sir.

Representative DURHAM. The only reason I asked the question is this: I recall when we built the school we built it on what I thought was a 10-year basis to take care of the personnel there.

General STARBIRD. The overall school program, sir, has been kept in balance with the number of children that are there.

Representative DURHAM. You just had an increase in children?

General STARBIRD. We keep adding small increments as the school population goes up. We are in a situation now where many of these youngsters born shortly after the war are beginning to enter school.

Representative DURHAM. I think when we held the hearings we had information that this real estate project was highly successful. It was something that the Government was getting good value for what we put into the property to begin with.

Representative VAN ZANDT. General Starbird, is this real estate development not made necessary by the fact that some of your Government-owned real estate has deteriorated to a point where you have to abandon it and the people must move somewhere else?

General STARBIRD. It is a little bit different than that, Mr. Van Zandt. What it is is this: Many of our people are senior people who have gotten to a point in life where they have needs in their housing beyond the type of housing that the Government provides. The Government here provides basically the same type of housing that you find in Wherry housing, and the like. These are very high type people. Many of them have dependents coming back on them. They want to move out in many cases and build their own homes and are willing to do this. Our program is an effort to let them do it.

Representative VAN ZANDT. What has happened to the small facilities?

General STARBIRD. Some of the old small ones have been removed, sir. They have generally been removed in parallel with the last of the increases in the Government housing which occurred up to about 2 years ago.

Representative VAN ZANDT. Have you many of them left?

General STARBIRD. We have a great many houses, sir, which are houses built in 1943. They are four- and eight-family, two-floor apartments. They are housing which we are keeping up but keeping up with a minimum of essential maintenance.

Representative VAN ZANDT. What about the one-family units?

General STARBIRD. I think around 35 percent of all the houses that are there are one-family units.

Representative VAN ZANDT. They were the original construction, were they not?

General STARBIRD. There are seven old one-family houses that were there as a part of the original school. Then for a period beginning in the 1943 period we generally built apartments, duplex units, and the like. Late in the period of the Government building of the community, we built better one-family houses. Those are the ones I was referring to when I said 35 percent are the one-family units.

NEW SIGMA LABORATORY

Representative DURHAM. Are we getting the laboratories out into that new building? Is that completed yet at Los Alamos?

General STARBIRD. It is completed and the laboratory has moved over to the side away from the community, sir.

Representative DURHAM. Is the old laboratory totally destroyed?

General STARBIRD. We are taking down the old laboratory, much of which not only was in extremely poor condition, but in certain cases elements were contaminated slightly and we did not want to hold those buildings any longer.

Mr. RAMEY. The subcommittee on communities held a hearing on the Los Alamos community problem in December, and I think we are getting our last statement in today and hope to get the volume of hearings published to bring matters up to date.

Representative DURHAM. You may proceed, Mr. Chairman.

GENERAL PROVISIONS

Mr. MCCONE. General provisions: Sections 102 through 106 of the proposed bill cover general provisions which are essentially unchanged from previous years.

AMENDMENT OF PRIOR YEAR PROJECTS

Amendment of prior year projects: Increased authorizations are requested for two projects approved in prior years.

ZERO GRADIENT SYNCHROTRON

Zero gradient synchrotron: It is proposed that the authorization for project 57–d–1, the zero gradient synchrotron being constructed at the Argonne National Laboratory, be increased to $42 million. The amount of $15 million originally authorized for this project was increased in fiscal year 1958 to $27 million, the amount now authorized. The proposed further increase of $15 million will permit undertaking additional associated facilities immediately, including modifications to the meson shield wall, external experimental proton areas, and increases in power supply, cooling systems, and machine controls. Completion of these additional facilities will make the accelerator's full potential available for research at the earliest possible date.

Representative VAN ZANDT. Mr. McCone, does this $42 million cover all the presently known required items in this project?

Mr. MCCONE. Everything.

Representative VAN ZANDT. Everything?

Mr. MCCONE. Everything, yes. The reason why this item had to be authorized at this time is because it affects the basic design of that part of the plant which is now authorized and under construction. Therefore, to modify part of the plant now being constructed to accommodate these additions, there must be some changes made right away, which would not be made if this authorization was not anticipated.

Representative DURHAM. Is that due to increased costs, Mr. Chairman, or is it due to miscalculations in the beginning on this amount of $15 million which, as I recall, was to complete the project.

Mr. MCCONE. I think it is due to three things, Mr. Durham. One is increased cost, the second is miscalculations, and the third and most important is the new developments in techniques which indicate that a machine of this kind by modification can be made more useful.

Representative DURHAM. You have not started yet, have you?

Mr. McCone. We are just starting. The excavation has been completed and foundations are being poured.

Representative Durham. Are you going to need this money this year?

Mr. McCone. No. There is very little money involved.

Representative Durham. This is just authorization.

Mr. McCone. This is authorization.

Representative Durham. How much are you asking for?

Mr. McCone. No part of the $15 million is to be budgeted this year.

Representative Durham. Why are you asking us to authorize more money, then?

Mr. McCone. We want to authorize it so that, in the design and construction of that part of the work which has been authorized, modifications can be made to accommodate these extensions at a future time.

Representative Durham. Have you got the money already to do the planning?

Mr. McCone. Yes, the planning can be done and will be done as an intergral part of the work that is going on now.

Representative Durham. And the design, too? Is there money available for designing?

Mr. McCone. The designing of the modifications of the existing plant can be accommodated. The designing of these additional facilities will have to come out of future appropriations.

Representative Van Zandt. Mr. McCone, does this authorization of $42 million include the cost of the building?

Mr. McCone. Yes.

Representative Van Zandt. Those in charge of the construction indicated to me in late December that they had some ideas of expanding the project. Are you familiar with the expansions of the project?

Mr. McCone. Yes.

Representative Van Zandt. Does this $42 million authorization include the expansion?

Mr. McCone. It includes all expansion that I know anything about.

Representative Van Zandt. Are we on schedule?

Mr. McCone. I think we are reasonably on schedule.

Representative Holifield. Mr. Chairman, as I look at these figures my mind reverts to the $105 million originally requested for Stanford, or $83 million originally requested for Stanford, and then $105 million. I am wondering if we are going up to something like $300 million on the Stanford linear accelerator before we get finished, or even get started on it. This is almost a three times increase. If we increase the orginal $83 million three times, then it would be around $240 million, or the present $105 million would make it around $300 million.

Mr. McCone. We have taken almost a year studying that subject now, Mr. Holifield.

Representative Holifield. If you can save another $100 million, take another year.

Mr. McCone. We have submitted some very recent reports to you. I think that Stanford accelerator is going to be the subject of a separate discussion with the committee. I do not think that question you raise is a probability. I think we have that question in hand.

Representative HOLIFIELD. I do not think we have ever built any one of these accelerators or synchrotrons yet that didn't run two or three times the original estimate.

Mr. MCCONE. I guess that is right.

Representative VAN ZANDT. Mr. McCone, I am still not satisfied with this $42 million authorization. Does this $42 million authorization include the necessary facilities to house laboratories of the physicists who will not only be employed but those who will visit the project?

Mr. MCCONE. It does not include physics laboratories nor does it include housing. This $42 million includes the original machine with the arrangement to take the beams off tangentially and the laboratories necessary to permit working with beams so taken off. There are two facilities for the taking off of beams and the necessary shielding and laboratory areas. It does not include physics laboratories, nor does it include housing for physicists who might come there to work.

I have no doubt that there will be such things as bubble chambers and so forth that will come along.

Representative VAN ZANDT. Can we anticipate that it will come along next year, or when?

Mr. MCCONE. I cannot answer that.

Representative VAN ZANDT. It is all contingent on the progress of construction?

Mr. MCCONE. No, it is not. This takes care of the facilities now envisioned. This is a rapidly developing business and it is quite possible that additional utilization of this machine will require further facilities. I cannot say that it will not. We have gone into these matters quite carefully, though, and we feel that this takes care of everything within the boundaries of the machine itself that we can foresee at this time, but no offsite construction.

Representative DURHAM. Certainly these machines are important and I think we ought to do what is necessary to further this field of high physics. I think we are going to have to think about using these things in some manner so that the people who have to have this information can be transferred to where we have already built one. It would be a little cheaper and I think the railroads need some business, anyway.

Mr. MCCONE. The difficulty is that the machines do different things. There are different sizes and different types. This machine is a machine for one purpose and the Stanford machine for another. This question has troubled me. This represents a very, very substantial effort and a very substantial continuing annual cost.

Representative DURHAM. I realize that. Before you mentioned that the maintenance and upkeep and personnel would cost how much?

Mr. MCCONE. $125 million a year.

Representative VAN ZANDT. Mr. McCone, as you said, this is a very substantial effort. In my visit to this area in late December I was impressed that way. I see here that the research division asks for $6.8 million to cover high energy physics research facility, ANL, and requested funding of $1.6 million and the submission shows authorization nothing and funding nothing.

Mr. McCone. That is right. That is a physics building which we did not allow because we did not think that it had to be authorized or funds appropriated at this time.

Representative Van Zandt. At this time.

Mr. McCone. That is right.

Representative Van Zandt. This is related to the facilities which were included in my question a moment ago.

Mr. McCone. I would say that this building will be necessary at some time. Whether you increase this authorization from $27 million to $42 million or do not, that will be true. It is a physics building that you need in conjunction with this machine regardless of the size of the machine. The $15 million additional authorization is not what creates the need for the physics building.

Representative Holifield. Mr. Toll.

Mr. Toll. Could Dr. McDaniel say in a very lay way exactly what type of experiments or work would be accomplished in this machine that could not be obtained from the Brookhaven machine or the Berkeley machine, or one of the others.

Mr. McCone. Mr. Chairman, I don't want to suggest that we not discuss these things as we go along, but I think this whole high energy physics problem is a matter that this committee will want to discuss and it might be well to go through my statement and then pull all of them together, because Lawrence Radiation Laboratory, Argonne National Laboratory, Brookhaven National Laboratory, Princeton-Pennsylvania and Harvard-MIT are involved. I think the committee should understand the interrelationship and the differences between each of those machines. If that would be agreeable to you, I think it might be a better approach to the question. I think this is one of the very important matters for the committee to consider and it is one certainly that the Commission has given a great deal of thought to.

Representative Holifield. We will withhold the question at this time and we will consider all of those together after you have finished your statement.

Mr. McCone. Thank you.

ALTERATIONS TO SHIPPINGPORT REACTOR FACILITIES

Alterations to Shippingport Reactor Facilities: The proposed bill will also increase from $5 million to $9 million the authorization for project 60–e–12, alterations to the Shippingport reactor facility. The second reactor core (PWR core 2) for the Shippingport plant represents a significant technological advancement over the first core. The principal objective of the PWR core 2 program is the development of a very high performance core in terms of both power density and lifetime. The PWR core 2 is expected to have about three times the energy output presently estimated achievable in PWR core 1 and a power density of about twice that of PWR core 1.

The power output of PWR core 2 will be equivalent to 150 megawatts gross electrical which is approximately 2½ times that of PWR core 1. In order to dissipate the higher power output of PWR core 2, it is necessary to either expand the electrical generating portion of the Shippingport plant from its present capacity of 100 electrical megawatts to 150 electrical megawatts and to provide additional

transmission lines or provide a suitable heat sink. Both these possibilities were throughly investigated by the Duquesne Light Co. and the Commission and it is jointly concluded that expanded electrical generation is not economically feasible under the circumstances. Use of a heat sink for power dissipation meets all the requirements for proving out the higher power capabilities and thus the developmental objectives of PWR core 2.

The PWR reactor has been used to conduct numerous tests of a technical and operating nature and much information has already been obtained; this developmental reactor plant should therefore continue to be operated for this important purpose of advancing reactor technology.

Approval of $9 million is, therefore, being requested for the Government to construct a heat sink and to modify the reactor plant to permit operation at a power level equivalent to 150 electrical megawatts.

Representative HOSMER. Mr. Chairman, may I ask what is the difference in cost between this heat sink approach and the addition of the generating and transmission facilities?

Mr. MCCONE. The generating and transmission facilities were to cost $22 million, including the transmission lines which, as I recall, were about $4 million. The heat sink costs about $4 million.

Representative VAN ZANDT. As I understand it, Mr. McCone, the Duquesne Light Co. people found that it was uneconomic for them to invest several million dollars in this project, is that correct?

Mr. MCCONE. No, sir. They found it was uneconomical to invest what they estimated would be the cost of the power end of it which was $22 million.

Representative VAN ZANDT. $22 million?

Mr. MCCONE. That is correct.

Representative HOLIFIELD. I was going to suggest to my colleagues, if it is all right with them, that when we get to the line item on this that we will discuss it on Thursday. I would like to have Admiral Rickover here at that time if it is possible, and we will go into it in some detail.

Mr. MCCONE. Very well. Admiral Rickover has carried on the negotiations as has a negotiating committee.

Representative HOLIFIELD. Will you proceed, please.

PROJECT RESCISSIONS

Mr. MCCONE. Project rescissions: Section 108 of the bill would rescind the authorization enacted in prior years, except for funds heretofore obligated, for the following projects which experience has proved to be unnecessary.

1. Project 60–c–2, special processing plant, Mound Laboratory, Ohio, phase II.
2. Project 59–b–4, special processing plant, Mound Laboratory, Ohio.
3. Project 59–c–8, lineal acceleration tester, Livermore, Calif.
4. Project 59–g–3, gamma process development irradiator.
5. Project 58–b–5, additions to scrap plants at various sites.
6. Project 58–c–2, weapons special component plant.

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7. Project 57-a-7, modifications to existing production facilities for increased efficiency and safety, Hanford, Wash.

FOOD IRRADIATION PROGRAM

Representative VAN ZANDT. Mr. McCone, going back to project 59-g-3, gamma process development irradiator, this involves $1.6 million.

Mr. MCCONE. That is right.

Representative VAN ZANDT. Could these funds be used for a civilian food irradiation program?

Mr. LUEDECKE. The funds have been given up for this facility.

Representative VAN ZANDT. Why were the funds given up?

Mr. LUEDECKE. They were applied last year, sir.

Representative VAN ZANDT. They were applied last year?

Mr. LUEDECKE. Yes, sir.

Representative VAN ZANDT. To what?

Mr. MCCONE. Mr. McCarthy, will you answer that question?

Mr. MCCARTHY. Yes, sir. In last year's revision of the 1960 budget, Mr. Van Zandt, the amount of funds previously appropriated, $1.6 million was used to reduce the fiscal year 1960 appropriation request. This money had been appropriated in 1959 but the determination was made last spring that there was no need of going forward with this facility. In fact, there was a letter to this committee dated April 29, 1959, which informed the committee of the action being taken. In preparing the 1960 budget estimates for submission to the Congress, the $1.6 million was applied to reduce the new appropriation request for 1960.

Representative VAN ZANDT. In other words, it is no longer available.

Mr. LUEDECKE. That is correct, sir.

PROJECT RESCISSIONS

Representative DURHAM. What is the total amount rescinded in your rescissions?

Mr. MCCARTHY. The total amount being rescinded this year in the authorization?

Representative HOLIFIELD. On the seven items?

Mr. MCCARTHY. It is roughly around $15 to $16 million. I will give you an exact figure on it. (NOTE.—The exact total is $18,290,000.)

Representative DURHAM. Since you have rescinded these items, does the appropriation committee require that those go back into the general fund?

Mr. MCCARTHY. No, sir. What we have done in each case is this, Mr. Durham, we either declared them to Congress as a reduction of the new appropriation being requested or applied them to going projects where we have had overruns. This is no-year money and as construction funds are available until expended, the bulk of the amounts appropriated for these items has been declared against the new appropriation request in prior years.

Representative DURHAM. The Appropriation Committee permits you to do that?

Mr. MCCARTHY. Yes, sir.

Representative HOSMER. This list of projects for rescission which have apparently been regarded as submarginal, are there other marginal projects that were also considered as possibilities for rescission?

Mr. MCCONE. These were the projects that were considered unnecessary in light of changes of program or technological developments.

Representative HOSMER. What I am getting at is that there are a good many other projects. Was there some evaluation made of some of the other projects, too, to find out if they ought to be rescinded?

Mr. MCCONE. Evaluations are made continually of all projects and there have been none that have come to the attention of the Comission that should be rescinded except these seven.

Representative HOSMER. Does that evaluation also consider the factor of money required by high energy research as against the particular projects and whether to continue them or not.

Mr. MCCONE. I don't know that I understand that question.

Representative HOSMER. Apparently, practically and necessarily you work within some bounds of total amount you want authorized and expended. These are broken down into a large number of individual expenditures for various projects of one nature or another. I am wondering since as a matter of necessity you must work within some expenditure limitation if some others of these projects are not considered candidates for rescission so that the money can go for such things as high energy research.

Mr. MCCONE. These being line items which have been previously authorized and in some instances items for which appropriations made by the Congress, at no time is a rescission of them considered in the light of any limitations on expenditures because that is already provided for. Rescissions are considered against the necessity of the facility.

Representative HOSMER. However, you have mentioned that as a practical matter so much money goes to high energy research.

Mr. MCCONE. That is true.

Representative HOSMER. And what proportion of your expenditures go to that? I am just wondering if you evaluate what can be obtained from the high energy research expenditure as against what can be obtained from continuing some of these projects.

Mr. MCCONE. No, I don't think that enters into it.

Representative HOSMER. Wouldn't that be a logical approach?

Mr. MCCONE. I wouldn't know how to do that, Mr. Hosmer.

Representative HOSMER. You come up here and you say we want to rescind certain projects because we feel that there is no longer a use for them. Possibly there would be some benefits gained from any one of these projects you rescinded but not the benefit you intended at the time it was authorized. There might be other projects from which the intended benefit might not be as great in magnitude as the benefits to be received from high energy research. I simply asked, Why should not perhaps some of these things be dropped and additional money spent on high energy research?

Mr. MCCONE. When we defend a project and the Congress authorizes it, then we will go ahead with that project unless technological developments or changes in our program indicate that the project is not necessary. We will not drop a project which we have declared as necessary in the interest of providing some additional money for

something that might be necessary. We will come in and ask you for more money, if that is the case.

Representative HOSMER. Would not just that consideration be a logical one? Would it not be a logical one from the standpoint of a business budget or even a domestic budget? Why should it not be from the AEC budget standpoint?

Mr. MCCONE. I think you would have such a process of continuing review and priorities that I don't know how that could be done.

Representative HOSMER. However, the sums are vast and we should be spending them for things which will gain us the greatest benefit. As the months and years pass, what gains us the greatest benefit changes. In the light of that it doesn't seem to me proper that the Commission should be inelastic in regard to its decisions of what to spend the money on.

Mr. MCCONE. I think it is not inelastic insofar as we reserve the right to come back and inform you that we are going to rescind an authorization which because of developments is no longer necessary.

I think, however, it would be a little too much elasticity to rescind an item because in the opinion of some of us some other item was somewhat more important. If another item that has not been authorized assumes that importance, we ought to come and ask for that.

Representative HOSMER. Let us put it in a gross manner then so that it can be more vivid. Assume that in the last 5 years the world energy picture has changed a great deal and made the necessity to acheive economic atomic power less intense than it was, and less possible because reduction in cost of conventional fuel makes it more difficult to achieve. Why should we not shift the emphasis of our expenditures from the power field to the research field under circumstances like that?

Mr. MCCONE. I think if the circumstances which you outline make it not in the national interest to go forward with power projects heretofore authorized it is our duty to come and tell you that we want to rescind them and why. On the other hand, if developments indicate that more money should be spent on high energy physics we ought to come and seek authorization. But I don't think one should be traded against the other. That is what I am trying to say.

Representative HOSMER. I think you have a point there in an individual but not in an overall sense. You have not apparently recommended yet a change in emphasis. I suppose you have considered that the existing relationship of these categories of expenditure is proper?

Mr. MCCONE. We think so. The sum of these authorizations was $18.3 million.

Representative HOLIFIELD. May I ask you at this time, Mr. Chairman, will you be able to be with us this afternoon?

Mr. MCCONE. Yes. I may be a few minutes late but I will be here as near to 2 o'clock as possible. Unfortunately I have a meeting that was scheduled to start at 11. I postponed it until 12. I hope it will be over and I will be back.

Representative HOLIFIELD. In view of that fact, let us adjourn at this time so it will give you a chance to get to your meeting. Let us make the meeting at 2:30 because we have some urgent business coming up on the floor and that will give us time to handle that, too.

Thank you.

Mr. McCONE. Thank you, sir.

(Whereupon, at 11:55 a.m. the hearing was recessed, to reconvene at 2:30 p.m. the same day.)

AFTERNOON SESSION

Representative HOLIFIELD. The subcommittee will be in order.

COOPERATIVE POWER REACTOR DEMONSTRATION PROGRAM

Mr. Chairman, we will go right ahead with this and when Mr. Van Zandt comes we will go back to the item he is interested in.

Mr. McCONE. Thank you.

I will now start on page 10 of my statement, cooperative power reactor demonstration program.

Section 109 of the bill will provide additional appropriation authority of $40 million to continue and augment our cooperative power reactor demonstration program in a manner consistent with the 10-year program recently presented to this committee.

I should like to point out that the 10-year program did not indicate a requirement for the construction of additional demonstration reactors in fiscal year 1961 in view of the status of prototypes or experiments being pursued in the various promising concepts. Reactors now authorized and in various stages of planning, construction, or operation are considered sufficient to provide the nuclear technology and operating experience necessary to demonstrate the steps required for further development. This is true both in the lower and intermediate power ranges.

There is the possibility that with respect to new concepts, specific applications of small size plants, or the construction of full-scale large plants, Government support may prove to be desirable. Flexibility in authorization is being requested, however, in order to take advantage of developments which may occur but which are not now firmly predicted.

Should acceptable proposals to construct an intermediate size organic-cooled power reactor not be received from the utility industry in response to the invitation issued by the Commission on January 22, 1960, the Commission, assuming the results of the research and development program demonstrate technical feasibility, would plan to construct this reactor at one of its sites at an estimated cost of $25 million.

Should the utility industry undertake this project, an alternative use of these funds would be for the Commission to undertake construction of a prototype reactor of some other design concept which might become sufficiently developed during the year to warrant such a decision. Construction of a spectral shift pressurized water reactor and construction of a small reactor at a remote location are two such possibilities.

The remaining $15 million of increased appropriation authority would be available for several alternative uses. Commission research and development assistance in support of unsolicited proposals might be determined to be most important if one or more utility companies were to accept a current offer of reactor manufacturers to construct

large reactors, or if they were to propose undertaking construction of prototypes of other reactor uses.

Representative HOLIFIELD. Going back to the previous paragraph, Mr. Chairman, where you spoke of a small reactor at a remote location, the AEC, as I understand it, requested the Bureau of the Budget for $11,600,000 for a nuclear powerplant at a remote military installation.

Have you dropped this completely out of your consideration or are you considering building it under the cooperative power demonstration program?

Mr. MCCONE. We have dropped out that particular project for the reason it is not eligible under our power demonstration program, either round two or three. This project was the Guam project. There was a need for an additional 20 megawatts of electrical power. It seemed to us after analyzing the fuel cost that a 20-megawatt nuclear plant of a design yet to be selected would be the proper way to supply that power.

The power cost would be no more expensive than the power cost from conventional means because of the high cost of fuel and the logistics involved. This matter was discussed with the Bureau of the Budget. We proposed to put in our budget $11,600,000, which would pay for the nuclear part of the plant and we proposed that the Navy provide the conventional part of the plant.

The Bureau of the Budget, in analyzing it, since the considerations were one of equality in the cost of fuel, felt that the whole thing should be supported by the Navy and suggested that the Navy budget for the entire project. The Navy determined that it was in their best interests, so I am told, to budget a lesser amount of capital expenditure in fiscal 1961 for a conventional plant and this, I understand, they plan to construct.

Representative HOLIFIELD. That seems to be a short-range way of looking at it which I can see would make the 1961 budget less. But at the time, it would eliminate the construction of a nuclear powerplant at a military installation which seems to favor the economics aand we would be short that one reactor in the program if that was the case. It becomes a matter of a budgetary consideration by the Navy rather than an advancement of the art.

Mr. MCCONE. That is very true, sir.

Our only alternative now is to select another location. As you know, we have a study to present to you in a very few weeks.

Representative HOLIFIELD. That study will be in by April 1?

Mr. MCCONE. Yes, sir.

It is for that reason, I understand, or that is one of the reasons you are calling for further hearings after the 1st of April.

Representative HOLIFIELD. We will take that up in detail in the April hearings.

The Navy has decided, as far as you know, if there is to be a plant there it will be a conventional plant?

Mr. MCCONE. So I am told.

Representative PRICE. The point here is, do you know what the Navy has done?

This was in their fiscal 1960 planning. They must have by this time decided on a course of action. Have they proceeded with plans that do not take into consideration a reactor?

Mr. McCone. That is my understanding.

I think General Luedecke is probably closer to the situation than I am.

Mr. Luedecke. I will have to call on Colonel Williams.

Colonel Williams. That is correct sir.

Representative Holifield. Will you please identify yourself for the record.

Colonel Williams. I am Chief of the Army reactors program for the AEC and the Army.

The Navy is going ahead with their plans for a conventional plant in 1961 funding. We hope that they will include a nuclear plant in their 1962 budget, but this we do not know for sure.

Representative Price. The point is, are they still giving consideration to tying this in eventually with a reactor program?

Colonel Williams. We hope so in 1962.

Representative Price. But the site of Guam will be eliminated.

It is possible that a nuclear plant, 20,000 kilowatts, can still be a later increment of power going in there.

Representative Holifield. Mr. Ramey.

Mr. Ramey. You said they were going ahead with 1961 funds although they have a 1960 authorization. Would it still be possible, if the Joint Committee were to restore this $11 million and provided that the Navy could use the funds that they have for a conventional plant, for the Navy to go ahead and do what their staff recommended and build a plant at Guam?

In other words, are they so far along in the actual design and construction of a conventional plant that this would get in the way?

This is a little surprising since the committee was considering this Guam site in its study which it authorized the Commission to undertake. For the Navy to go ahead and say it is going to build a conventional plant is surprising.

Mr. McCone. The history of the project is just as I have outlined it.

Mr. Ramey. How far along is the Navy, Colonel?

Colonel Williams. They are in design only. The plant was authorized in 1960, but not funded.

Mr. Ramey. It was in the 1960 military public works bill.

Colonel Williams. I believe so, sir.

The plan is that it will be funded in 1961 for the first 20,000 kilowatt increment, and built, based on a design which they have.

Representative Holifield. Do you happen to know what the overall cost of a conventional plant would be?

Colonel Williams. On the order of $10 or $11 million, I believe.

Representative Holifield. The operating cost. You have to get the oil there from the Far East; do you not?

Colonel Williams. Yes, sir.

Representative Holifield. What is the comparison of projected operating cost of the conventional plant as against the 20,000 kilowatt nuclear plant?

Colonel Williams. The latest figures we have, sir, show that including the annual operating costs which must be budgeted by the Navy, in this case, plus 5 percent escalation and, straight line depreciation on the initial cost, the nuclear plant at Guam would cost

about 13½ mills per kilowatt-hour. The conventional plant about 15.6 mills per kilowatt-hour. They are very close.

From a cumulative expenditure point of view, the nuclear plant would break even with the conventional plant in about 19 years.

Representative PRICE. Mr. Chairman, I am going to make this suggestion to the committee: I am not a member of your subcommittee, but I think before you complete action on this authorization bill you should have both the Navy and the Army in here to give specific testimony on the suggested location of reactors in Okinawa and Guam; Okinawa for the Army and Guam for the Navy.

Representative HOLIFIELD. I think that is a good suggestion. We might be able to work them in on Thursday. We will notify you if we want to go into this matter further.

Thank you, Colonel Williams.

Will you proceed, Mr. Chairman.

Mr. MCCONE. For this purpose the limitation on use of appropriation authority for research and development assistance in support of unsolicited proposals from the utility industry to construct nuclear powerplants would be increased from $5 million to $20 million. Alternatively, part or all of the $15 million could be used for research and development support for a third round type of proposal which might be invited, if construction of a prototype of one of the reactor concepts now being studied is determined to be desirable.

Section 109 would also provide authority for waiver of an additional $5 million in use charges for special nuclear materials and heavy water in connection with cooperative power reactor demonstration projects.

Representative HOLIFIELD. Is this $5 million set aside for specific reactors which are now being planned?

Mr. MCCONE. No. We do not have any specific reactor.

As I have told you, there are two active negotiations which are being carried on.

Representative HOLIFIELD. It will be some time before nuclear materials would be needed for them even if they materialize?

Mr. MCCONE. Quite some time, Mr. Chairman.

COOPERATIVE RESEARCH AND DEVELOPMENT PROGRAM WITH CANADA

Cooperation with Canada: Last September, in its initial budget formulation for 1961, the Commission provided for the construction of a natural uranium, heavy water moderated reactor. During the period since then, however, discussions were carried on with Canada leading toward a cooperative arrangement in this field.

Since Canada has determined to construct a prototype and large-scale plant of this concept, it was considered appropriate to avoid duplication by a cooperative agreement. For this reason the Commission decided not to request the construction of this reactor at this time.

It is comtemplated that a joint program to advance the technology of heavy water power reactors will include research and development efforts by AEC specifically directed to the design and construction by Atomic Energy of Canada Limited (AECL) of power reactors of that type in the Dominion of Canada. These reactors will include—

(*a*) A prototype 20-megawatt (electrical) power station (NPD) currently under construction with initial criticality expected in the spring of 1961. The estimated cost of this prototype is $32 million.

(*b*) A full-scale 200-megawatt (electrical) power station (CANDU) under construction with initial criticality estimated at mid-1964; the estimated costs for this plant are $60 million for construction with an additional amount of approximately $20 million for design and development.

The mid-1964 date is the date established by the Canadians. We have not had an opportunity to check that.

Representative HOLIFIELD. As I understand these projects, there will be a total cost of around $112 million?

Mr. MCCONE. That is right.

Representative HOLIFIELD. The AEC is going to contribute about $5 million to research and development?

Mr. MCCONE. Yes, sir. I comment on that in a paragraph or two.

Representative HOLIFIELD. Does that entitle us to all the information that is developed in those projects or just the information that is developed in our own laboratories for the expenditure of the $5 million?

Mr. MCCONE. It gives us all the information. My statement covers it, if I could proceed.

(*c*) A heavy water moderated organic cooled type of power reactor (OCDRE) a 40-megawatt (electrical) prototype of which is planned to be constructed, contingent upon the results and conclusions of Canada's current design and development program.

Section 110 of the bill would authorized appropriation of $5 million for use in research and development of fuels, reactor components and design features, as well as the use of AEC facilities for irradiation and testing purposes.

Negotiations are now in progress on a memorandum of understanding which will set forth the undertakings of AECL and AEC. This cooperative program will be an implementation of the general agreement for cooperation between the Governments of the United States and of Canada, which came into effect on June 5, 1955. Although no commitment is being made in the memorandum of understanding, Canada may approach the AEC in the future requesting loan or lease of heavy water and special nuclear materials for use in their reactors. In the event such a request develops, the agreement for cooperation will require an appropriate amendment and such an amendment would be placed before your committee in the usual manner.

The $5 million which the Commission would spend for research and development in the United States is for work specifically directed toward the heavy water reactors to be constructed by Canada. If unforeseen circumstances should cause Canada to decide not to continue its program of constructing the NPD and CANDU heavy water reactors, the United States would not continue the research and development work directed toward the Canadian plants.

Under this arrangement we will obtain for use by the Commission, its contractors and American industries all the engineering and economic information, including drawings, plans, specifications, and all other technical data, developed under the Canadian heavy water

reactor program and all the rights to developments and patents that would accrue if AEC were to proceed with the development and construction of such a plant in the United States. A copy of the memorandum of understanding will be provided your committee as soon as the details are worked out with the Canadians.

Representative HOLIFIELD. My comment on that, of course, would be that if this program moves forward with deliberate speed, this would undoubtedly be a bargain to get the information on $112 million worth of reactors for $5 million.

What assurance do we have that this program is going forward? How firm is it? How much can we depend upon it? How many years is this going to take?

Mr. MCCONE. We feel it is very firm, Mr. Chairman.

The first plant, as mentioned here, is under construction, NPD, and is expected to go critical in the spring of 1961. That is going along.

They are pursuing the engineering on the second plant energetically and we have every reason to believe they will go forward.

The memorandum of understanding does not bind them to do this. They naturally reserve the right to cancel this undertaking if it appears that the plant will not serve its purpose. For that reason we inserted a caveat in the memorandum and in our discussion, that if they did not go forward then we are not obligated to continue our research and development, and we would fully expect to move ourselves unless the conditions which caused them not to go forward likewise would be conditions which would make it unwise for us to go forward.

Representative HOLIFIELD. Will you proceed, please?

COOPERATION WITH EUROPEAN ATOMIC ENERGY COMMUNITY

Mr. MCCONE. Euratom: In view of recent developments in the Euratom program, no additional authorization for research and development is being requested. The $10 million now authorized appears more than sufficient to cover the requirements of the SENN program and any additional proposals received during the year. Additional proposals for reactors to be constructed by 1965 will be invited this year. The response to these proposals will determine the amount of future authorization which will be requested.

Senator DWORSHAK. Mr. McCone, I presume you have had a partial interim report from Mr. McKinney, who has been authorized by the Joint Committee to make a survey and study of the progress being made by the Euratom program. We had a report—I presume much of it is classified—before the committee that this Euratom program is virtually grounded.

In view of that, it would seem somewhat inappropriate to ask for proposals for reactors.

I am sure that you have kept abreast of these developments, and I should like to ask you if you still expect Euratom to make any progress?

Mr. MCCONE. I feel, Senator Dworshak, that there is a possibility that one or possibly two proposals, in form that would be acceptable to us, would be received.

The Commission feels that the best procedure for us to follow is to arrange with Euratom for the issuance of the invitations and see if the bids will be forthcoming.

Senator DWORSHAK. I recall 2 years ago when your associates sold the Joint Committee this program in a very persuasive and forceful manner, the justification for our participation was on the basis that we would receive much pertinent research and development information.

In view of the fact that little if any progress has been made and that those who were negotiating with us 2 years ago now have almost abandoned the program, what do you propose to do to get the research and development which will not now be available from the Euratom program?

If it justified our participation 2 years ago and now it is virtually at a standstill, are we going to lose or forfeit any research information which we might have expected?

Mr. MCCONE. We are naturally hopeful that Euratom plants would serve the purpose of which you speak. We are disappointed that they have not gone forward.

Of course, conditions have changed, and I have no doubt that Mr. McKinney went over that in considerable detail with you.

We feel that our program of research and development and the construction of plants of various types is meeting our need. If Euratom would come forth with one or two more plants, it would be helpful because every little bit of information and every development seems to help in this new area.

I see no reason to do other than to follow a policy of permitting the utilities in Europe to consider this 1965 proposal and see what is forthcoming.

Senator DWORSHAK. Is the Commission proposing any alternative program here to provide stimulus for developing nuclear powerplants?

Mr. MCCONE. In Europe, no.

Senator DWORSHAK. In this country, if we felt it was necessary to spend a lot of money to help accelerate this development program in Europe. If it is at a standstill, does the Commission feel that there is any justification for setting up some alternative program in this country or will we just lose automatically any potential benefits which we might have gained from the successful operation of Euratom?

Mr. MCCONE. We have outlined a program which we intend to follow which will call for plants that have been identified to this committee in the 1960 202 hearings on the state of the atomic energy industry. We have every confidence that these plants will be built. Some of the prototypes may not be built by industry and we will have to arrange to have them built either by round two or as our own facilities and consume the power ourselves.

We do not intend to let this technology just lie dormant because Euratom decided not to build some plants. We are going to go right forward.

Senator DWORSHAK. Then you do feel that notwithstanding the disappointing results achieved in the Euratom program, that your Commission is cognizant of the responsibility to do what is necessary to accelerate power development—nuclear power development—in this country.

Whether you have already proposed some alternative program, you do intend to recognize this problem?

Mr. McCone. We recognize it; yes, sir.

Representative Holifield. Will you proceed, please?

CONCLUSION OF GENERAL STATEMENT

Mr. McCone. Conclusion: Two studies are now being readied for submission to this committee by or before the 1st of April. These are studies on a reactor for remote military installations and on a reactor suitable for application to power a tanker. The progress being made in carrying out the 1960 authorization for the power demonstration program has been recently reported to you.

Unless there are general questions of a policy nature the committee wishes to direct to me, I would suggest that presentation of the details of our proposed legislation be continued by the General Manager.

Thank you, Mr. Chairman.

Representative Holifield. Before we go to that, in addition to the two studies which are expected by April 1, you will also give us a report on the safety and the indemnity reporting, will you not?

Mr. McCone. Yes, we will do that.

Representative Holifield. I think after that we will want to take up some of this site criteria.

Mr. McCone. Yes. There are some problems in connection with site criteria that we must discuss with you.

We have the Canadian question for the plants that are in the far north. This we have to discuss with you.

Also, there are some matters that have been brought up by the Advisory Committee on Reactor Safeguards in connection with such things as inversion in California that we have not resolved yet and which are perplexing to us.

Representative Holifield. We will go into that in more detail after we get the safety report.

Mr. McCone. Yes, sir.

Representative Holifield. Before we continue, could you give us a quick summary of the status of the natural circulation reactor and the power reactors under the second and third round?

NATURAL CIRCULATION TEST PLANT

Mr. McCone. Yes. The natural circulation reactor, which is a Navy project, has been assigned to the KAPL Laboratory. It is proceeding.

The General Manager, I think, can give you the exact schedule of construction of it.

Representative Holifield. That is in Idaho, I believe, is it not?

Mr. McCone. It will be built in Idaho, yes.

Have you the schedule on the natural circulation reactor?

Mr. Luedecke. No, sir; we haven't. We planned to take it up on Thursday.

Mr. McCone. It is under Admiral Rickover's cognizance. Engineering is proceeding and they will start construction prior to the end of this year.

COOPERATIVE POWER REACTOR DEMONSTRATION—ROUND 2

With respect to the round 2 projects, Mr. Zinn made a report to us on schedule on the 30th of November, last year, on the BONUS project which is the boiling water superheated reactor.

After evaluation, we decided that the reactor should be built. Successful negotiation was concluded with the Puerto Rican water authority. Contracts have been let for the design and construction and building and operation of the plant.

The second round-2 reactor was a small demonstration reactor on the order of 15 to 20 megawatts to prove out the possibilities of economical power.

A study was conducted by the Commission staff with the assistance of the Oak Ridge Laboratory. Three reactor concepts were evaluated: pressurized water, boiling water, and organic. The decision was reached that the most economical and the most dependable plant under existing technology was a small pressurized water plant.

Invitations were issued and five proposals were received from communities for second round. We have made a tentative selection and the Advisory Committee is considering that site. We are hopeful that they will approve it. If they do not approve it, then we will have to consider one of the alternate proposals.

The contracts have been let for engineering and that work is proceeding to the extent possible in view of the selection of the site.

The larger reactor, which is a 50-megawatt boiling water reactor, involving all of the various developments that will simplify construction and reduce cost, is to be a second round proposal.

We have issued invitations for that. They have not been returned as yet. That will be about a 50-megawatt reactor, as I said.

This is the type of reactor that will be very useful in itself, but it will be particularly useful as a prototype for larger natural circulation boiling water reactors of simplified design. Those contracts will be awarded within the next few months.

I think those are the only outstanding round 2 developments.

NATURAL CIRCULATION TEST PLANT

Senator Dworshak. Mr. McCone, you briefly referred to project 60–e–11, the natural circulation test plant and stated that as it had been authorized by the Congress it was planned to be built in Idaho.

Have any plans been made to initiate work on that project?

Mr. McCone. Yes. That is going forward.

As I said, construction work will be started this year.

Representative Holifield. At this point we will insert in the record, unless there is objection, the material which was furnished us by the Atomic Energy Commission under date of March 1 on the status of these different projects which are now contemplated or are underway.

(The information referred to follows:)

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
February 11, 1960.

Maj. Gen. A. R. LUEDECKE,
General Manager, U.S. Atomic Energy Commission.

DEAR GENERAL LUEDECKE: It is requested that the Commission furnish the Joint Committee a report by March 1, 1960, on the following projects, authorized by Public Law 85-590 and Public Law 86-50: Project 59-a-5; projects 59-d-10; 59-d-12 through 16; 59-e-1 through 15; 60-e-11; 60-e-12; 60-e-13; 60-e-14; and 60-e-15. In addition, this report should summarize developments in the power demonstration program as authorized by section 109, Public Law 85-590, and section 110, Public Law 86-50.

With respect to the above-mentioned projects, it is suggested that the report indicate, among other things, the amount of funds allotted and obligated, and the status of contract negotiations and construction.

Sincerely yours,

JAMES T. RAMEY,
Executive Director.

ATOMIC ENERGY COMMISSION,
Washington, D.C., March 1, 1960.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: By letter dated February 11, 1960, Mr. Ramey requested that the Commission furnish your committee a report on a number of projects in prior-year authorization acts.

The requested information is attached hereto.

Sincerely,

R. E. HOLLINGSWORTH,
Deputy General Manager.

U.S. ATOMIC ENERGY COMMISSION REPORT TO THE JOINT COMMITTEE ON ATOMIC ENERGY CONCERNING CERTAIN PROJECTS AUTHORIZED BY PUBLIC LAWS 85-590 AND 86-50 AS REQUESTED IN MR. RAMEY'S LETTER OF FEBRUARY 11, 1960

SPECIAL NUCLEAR MATERIALS PROGRAM

59-a-5. Production reactor facility for special nuclear materials, convertible type, Hanford, Wash.

Design status as of January 31, 1959, was estimated to be 38 percent complete versus 37 percent scheduled. Construction status was estimated to be 0.2 percent versus 0.3 percent scheduled. Work has been started on the administration building, site grading of the construction area, and installation of a telephone cable, temporary water lines, power transmission and distribution lines, access roads, river water pump house, modification of fuel element test facilities, and new fuel element cladding facility. The rehabilitation of the central concrete batch plant is substantially completed.

Construction of the reactor block and attached components, reactor instrumentation, graphite machining, and on-site process tube preparation are planned for cost-plus-fixed-fee work by Kaiser engineers. Sixty fixed-price subcontracts are planned, of which 13 have been awarded. An additional 10 are scheduled to be awarded from February through July 1960.

Present employment on NPR totals 106 Kaiser employees, 32 construction subcontractor employees, and 300 engineering employees. Construction employment of all contractors is expected to attain a maximum of approximately 1,800 in June 1961.

Total material and equipment procurement for the project is estimated to be $75 million, of which $43 million is for engineered items and critical material. Purchase orders approximating $10 million have been placed. Deliveries of materials and equipment were on schedule as of January 31, 1959; 1.5 percent of the total requirements having been delivered. Present indications are that the recently settled steel strike will not have a serious effect on future deliveries.

Of the $10 million on purchase orders placed, $4.6 million is for the main heat exchangers to be procured from Combustion Engineering, Inc. Other

significant purchase actions include an order for circulating (river) water pumps ($403,900), pilot orders for Zircalloy process tubes ($3 million), reflector graphite ($400,000); and a gantry crane ($175,000). Proposals for the design fabrication and delivery of primary cooled water pumps are being evaluated.

Bids have been issued for the excavation and substructure of the reactor building and the excavation and footing for the heat exchanger building. Bids are open and being evaluated for the standby power boiler and standby turbogenerator.

The NPR is unlike the existing single-purpose reactors in that the temperature and pressures of the coolant will be sufficiently high to permit the production of steam in a secondary circuit suitable for use in turbine generators. The principal provision to be built into the reactor to provide for future conversion to either dual-purpose or power-only operation consists of heavy-walled zirconium process tubing and piping and pumps suitable for use at elevated temperatures and pressures. Steam generators for use under production, dual-purpose, and power-only conditions also will be included. This equipment will remove heat from the reactor in the form of steam which could be used in turbogenerators if subsequently installed for power recovery.

Because of the higher than normal operating temperatures and pressures, a large amount of research and development has been necessary before a final design of many of the reactor components is possible. The design and development program now totals 103 items; 23 of these items have been completed, 65 are in progress, and 15 are in the planning stage. The overall program is estimated to be 55 percent complete against 62 percent scheduled. Testing and development work for any specific item will continue until completion, if time permits, with the most critical items having priority. Requisitions will be issued on schedule even if the design development work is not complete. In all cases, a satisfactory and workable item of equipment will be available, but possibly not developed to the highest degree, should the construction schedule require the issuances of requisition before completion of all of the development plan for an individual item. The design development program will not delay the overall NPR program.

Financial data as of January 31, 1960

Financial:	
Amount authorized	$145,000,000
Present cost estimate	[1] 145,000,000
Amount allotted	[2] 120,000,000
Obligated	
Costs incurred	5,764,000

[1] A preliminary estimate of $152,200,000 presently being reviewed within the Commission contains costs of supporting facilities which were not included in the original estimate of $145,000,000.

[2] An additional $25,000,000 is being requested in the fiscal year 1961 appropriations bill.

Percentage complete:

Design 38 Construction 0.2

REACTOR DEVELOPMENT PROJECT

59–d–10 Gas-cooled power reactor

Contractors.—

Operation: In process of selection.

R. & D. and Design: Oak Ridge National Laboratory, Kaiser Engineers, Allis-Chalmers Mfg. Co.

Construction: H. K. Ferguson Co.

Construction continuing. A subcontract for the steel containment shell was awarded to the Pittsburgh Des Moines Steel Co. Construction started in August 1959 and is scheduled for completion in October 1962.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$30,000,000
Present cost estimate	$30,000,000
Amount allotted	$30,000,000
Amount obligated	$8,740,504
Costs incurred	$2,119,981

Financial data and status of construction as of Jan. 31, 1960—Continued

Percentage complete:	
Design	45
Construction	3

REACTOR DEVELOPMENT PROJECT

59–d–12 Design and engineering study of heavy water moderated power reactor

Work was performed by Sargent & Lundy which involved evaluation of heavy water, natural uranium reactors, and selection of optimum concepts. Nuclear Development Corp of America, subcontractor to Sargent & Lundy, performed the nuclear design evaluation. In accordance with Public Law 85–590, the results of these studies were transmitted in a report to the Joint Committee on Atomic Energy.

Financial data as of Jan. 31, 1960

Amount authorized	$4,500,000
Percent cost estimate	1,459,300
Amount allotted	1,459,300
Amount obligated	1,459,300
Costs incurred	1,346,991

59–d–13 Design and engineering studies of two large-scale power reactors and one intermediate size prototype power reactor

This project involved the performance of design and engineering studies and furnishing of conceptual designs by three contractor teams on three reactor concepts, as follows:

(Large scale) Pressurized water: Stone & Webster and Combustion Engineering.
(Large scale) Boiling water: Ebasco Services and General Electric Co.
(Intermediate) Organic cooled: Bechtel Corp and Atomics-International

All work has been completed and reports on the studies were submitted to the Joint Committee on Atomic Energy as required by Public Law 85–590.

Financial data as of Jan. 31, 1960

	Amount authorized	Present cost estimate	Amount allotted	Amount obligated	Costs incurred
PWR	$6,000,000	$771,000	$771,000	$771,000	$760,439
BWR		700,000	700,000	700,000	634,623
OCR		795,000	795,000	795,000	789,603
Total	6,000,000	2,266,000	2,266,000	2,266,000	2,184,665

59–d–14 Design and engineering study of a power reactor of advanced design capable of utilizing nuclear superheat, such study to be undertaken either as a cooperative project or conducted solely by the AEC

General Nuclear Engineering Corp. (a subsidiary of Combustion Engineering, Inc.), the subcontractor of the Puerto Rico Water Resources Authority, has completed its work under this project and the final technical feasibility report and a preliminary hazards report was submitted to the Commission in January 1960. Also a report on the study was furnished the Joint Committee on Atomic Energy as required by Public Law 85–590. The design calls for a 16.3 net MWE direct cycle, forced circulation, integrally coupled, boiling and nuclear superheat core, using slightly enriched UO_2 as fuel. Construction of this reactor was authorized in fiscal year 1960 under project 60–e–15, Public Law 86–50.

Financial data as of Jan. 31, 1960

Amount authorized	$750,000
Present cost estimates	300,000
Amount allotted	280,000
Amount obligated	278,277
Costs incurred	278,277

59–d–15 Metals ceramics building, Oak Ridge National Laboratory

Design work started on March 6, 1959. Construction is scheduled for completion January 31, 1962. Title II work for fixed-price construction completed January 12, 1960. It is estimated that title II for CPFF equipment installation

will be completed by March 15, 1960. Giffels & Vallet, Inc. is A–E. Bids for award of prime construction contractor scheduled to be opened on February 25, 1960.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$6,500,000
Present cost estimate	$6,500,000
Amount allotted	$6,500,000
Amount obligated	$957,352
Costs incurred	$699,978
Percentage complete:	
Design	97
Construction	3

59–d–16 Metals process development plant, Ames, Iowa

Engineering work by Tinsley, Higgins, Lighter, & Lyon complete. Fixed-price contract awarded to W. A. Kingler for construction. Building construction estimated to be completed on August 1960 with equipment procurement and installation scheduled for completion on October 1960.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$1,900,000
Present cost estimate	$1,900,000
Amount alloted	$1,900,000
Amount obligated	$1,591,257
Costs incurred	$316,055
Percentage complete:	
Design	100
Construction	34

PHYSICAL RESEARCH PROJECTS

59–e–1 Accelerator improvements, University of California Radiation Laboratory, Calif.

This project provides for improvements to the existing Berkely accelerators in fiscal year 1959 and 1960. The sum of $800,000 was appropriated, allotted and obligated in fiscal year 1959 with the remaining $525,000 appropriated, allotted, and obligated in fiscal year 1960. Work started in January 1959 and the total project is scheduled for completion in August 1961. Design, procurement, and construction is being done by LRL (prime contractor) forces or under fixed-price subcontracts.

Regarding the $800,000 portion undertaken in fiscal year 1959, design is 83 percent complete and construction 68 percent complete. Completion is scheduled for November 1960. For the fiscal year 1960 portion—$525,000—work is to be completed by August 1961.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$1,300,000
Present cost estimate	1,325,000
Amount allotted	1,325,000
Amount obligated	1,325,000
Costs incurred	468,000
Percentage complete: See above.	

59–e–2 CP–5 Reactor improvements, Argonne National Laboratory, Ill.

This project is nearing completion. Design, procurement, and construction is being done by Argonne forces or under fixer-price ANL subcontracts. Major construction work is being done by Telander Bros. Contractors, Inc. The work, which was started in August 1958, is scheduled for completion in February 1960.

Financial data and status of construction as of Jan. 31, 1950

Financial:	
Amount authorized	$500,000
Present cost estimate	$487,000
Amount allotted	$487,000
Obligated	$487,000
Costs incurred	$368,000
Percentage complete:	
Design	100
Construction	97

59–c–3 Two accelerators, beam analyzing system and magnet, Pennsylvania State University, Pennsylvania

Pennsylvania State University has purchased with its own funds a 5.5 Mev. Van de Graaff generator. The Commission is providing funds (from the operating expenses appropriation) in the amount of $213,000 for the initiation of a nuclear physics research activity. A proposal submitted in November 1959 by the university requesting Commission support for the purchase of a second accelerator has been evaluated. Pennsylvania State University is being informed that technical review of the proposal indicated that it would be premature to launch the linear accelerator project until the university has installed and operated its Van de Graaff machine for a period of at least 1 year, but that the Commission would be willing to give further consideration to a proposal for the provision of a linear accelerator at the end of that period.

59–c–4 Cyclotron, University of California Radiation Laboratory, Calif.

Work started in October 1958. Building design is being done by Gerald M. McCue & Associates, and machine design by LRL forces. Building construction by Robert L. Wilson started in September 1959.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$5,000,000
Present cost estimate	$4,600,000
Amount allotted	$4,600,000
amount obligated	$4,600,000
Costs incurred	$831,000
Percentage complete:	
Design	39
Construction	25

59–c–5 Central research laboratory addition, Oak Ridge National Laboratory

Design by A. M. Kinney and Union Carbide is complete. Construction by J. A. Jones started in February 1959. The project is scheduled for completion in March 1961.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$3,500,000
Present cost estimate	$3,057,000
Amount allotted	$3,057,000
Amount obligated	$2,804,000
Costs incurred	$1,331,000
Percentage complete:	
Design	100
Construction	42

59–c–6 Chemistry building addition, University of California Radiation Laboratory, Calif.

Design is being done by Gallis and by LRL forces. Construction started in November 1959 by Rotschild, Raffin & Werrick. This project is scheduled for completion in April 1961.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$2,000,000
Present cost estimate	$2,000,000
Amount allotted	$2,000,000
Amount obligated	$2,000,000
Costs incurred	$202,000
Percentage complete:	
Design	73
Construction	5

59-e-7 Chemistry Hot Laboratory, Argonne National Laboratory, Ill.

Conceptual design work started by Argonne forces. Catalytic Construction Co. has been selected to perform A-E services. Construction is expected to start in June 1960 and to be completed in December 1961.

Financial data as of Jan. 31, 1960

Financial:	
Amount authorized	$4,400,000
Present cost estimate	$4,400,000
Amount allotted	$4,400,000
Obligated	$330,000
Costs incurred	$3,000
Percentage complete:	
Design	0
Construction	0

59-e-8 Expansion of stable isotopes production capacity, Oak Ridge National Laboratory

Design work by Catalytic Construction is complete. Preliminary construction work started by Union Carbide in February 1959. Main construction contract (fixed price) was awarded to Rentenbach Engineering Co. in November 1959. This project is scheduled for completion in August 1960.

Financial data as of Jan. 31, 1960

Financial:	
Amount authorized	$900,000
Present cost estimate	$900,000
Amount allotted	$900,000
Obligated	$792,000
Costs incurred	$310,000
Percentage complete:	
Design	100
Construction	31

59-e-9 High energy physics building, Columbia University

Design by Ferrenz & Taylor is complete. Construction by A. M. Hunter & Son started in September 1959. The project is scheduled for completion in August 1960.

Financial data as of Jan. 31, 1960

Financial:	
Amount authorized	$500,000
Present cost estimate	$500,000
Amount allotted	$500,000
Obligated	$500,000
Costs incurred	$101,000
Percentage complete:	
Design	86
Construction	23

59-e-10 Particle accelerator program addition, Harvard-MIT accelerator

Design by Charles T. Main is complete. Construction started in December 1958. Construction includes a power building expansion (by S. & A. Allen

Construction Co.), a laboratory building expansion (by Peabody Construction Co.), and an experimental area expansion and cryogenic building (by Farina Construction Co.). The power building addition is complete. The project is scheduled for completion in June 1960.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$1,300,000
Present cost estimated	$1,430,000
Amount alloted	$1,430,000
Obligated	$1,430,000
Costs incurred	$756,000
Percentage complete:	
Design	100
Construction	66

59–e–11 High flux research reactor, Brookhaven National Laboratory

In October 1959, the Lumnus Co., New York City, was selected as architect-engineer for the project. Research and development work is continuing and considerable preliminary design work has been performed. Completion of definitive design is scheduled for December 1960 and completion of construction for January 1963.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$10,000,000
Present cost estimate	$10,000,000
Amount alloted	$10,000,000
Obligated	$750,000
Costs incurred	$51,000
Percentage complete:	
Design	7
Construction	Not started

59–e–12 Research and engineering reactor, Argonne National laboratory, design end engineering

Further review of this project by Argonne indicated that the proposed project would not be adequate for the needs of the laboratory. ANL has submitted a new proposal for a special high flux reactor that the laboratory feels would meet its needs. This proposal is currently under review by Commission staff.

59–e–13 Van de Graaff accelerator, Argonne National Laboratory

A contract for the procurement of the machine was signed in November 1959 with High Voltage Engineering Co. Delivery time is expected to be about 18 months. Design work on the building started in January 1960 by Argonne forces and by Skidmore, Owings, and Merrill. Construction is scheduled to start September 1960 and to be completed in September 1961.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$2,500,000
Present cost estimate	$2,500,000
Amount allotted	$2,500,000
Amount obligated	$1,302,000
Costs incurred	0
Percentage complete:	
Design	0
Construction	0

59–e–14 Cyclotron, Oak Ridge National Laboratory

Work started in October 1958. Design by Catalytic Construction Co. is complete. Design work by Union Carbide is 50 percent complete. Site preparation and preliminary construction started in October 1959 by H. K. Ferguson Co. Main construction contract was awarded to Foster & Creighton Co. in December 1959. Procurement of cyclotron components is 30 percent complete. The project is scheduled for completion in May 1961.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$3,000,000
Present cost estimate	$3,725,000
Amount allotted	$3,725,000
Amount obligated	$2,775,000
Costs incurred	$561,000
Percentage complete:	
Design	3
Construction	75

59–e–15 Research reactor, Ames Laboratory

Conceptual design architectural and engineering work started in January 1960. CPFF contracts were awarded to AMF Atomics for design of the nuclear portion of the project, and to Burns & Roe for conventional architectural and engineering work. Construction is scheduled to start in July 1960 and to be completed by June 1962.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$3,800,000
Present cost estimate	$3,765,000
Amount allotted	$3,765,000
Amount obligated	$521,000
Costs incurred	0
Percentage complete:	
Design	0
Construction	0

REACTOR DEVELOPMENT PROJECT

60–e–11 Natural circulation test plant, National Reactor Testing Station, Idaho

The Knolls Atomic Power Laboratory is conducting research, development and conceptual design work on the natural circulation reactor concept for naval ship application. Various core concepts are being reviewed to determine the optimum conceptual design for use with natural convection. Plant characteristics are being optimized and reviewed for compatibility with various core concepts and ship environmental requirements.

Financial data as of Jan. 31, 1960

Amount authorized	$18,500,000
Present cost estimate	18,500,000
Amount allotted	[1] 6,000,000
Obligated	0
Costs incurred	0

[1] $6,000,000 appropriated in fiscal year 1960, balance to be appropriated in fiscal years 1961 and 1962.

60–e–12 Alterations to Shippingport reactor facility

The purpose of this project is to modify the Shippingport reactor plant to permit operation at 150,000 kilowatt gross electrical output in order to test reactor cores of higher power output. The present capability of the generating plant is 100,000 kilowatt gross electrical. The report of the JCAE on the authorizing legislation specifies that the modifications to the reactor plant should be contingent upon corresponding action by Duquesne Light Co. to provide an increase in the turbine generator facilities. The AEC has not been able to conclude a satifactory arrangement with Duquesne Light Co. for construction of the additional turbine generator facilities; as a result, work has not been initiated on the reactor plant modifications. Duquesne has submitted an alternate proposal for construction of a heat sink in lieu of additional turbine generator facilities. The proposed authorization bill for fiscal year 1961 provides for an increase in authorization from $5 million to $9 million to permit construction of the heat sink by the Government.

Financial data as of Jan. 31, 1960

Amount authorized	[1] $5,000,000
Present cost estimate	9,000,000
Amount allotted	0
Obligated	0
Costs incurred	0

[1] Fiscal 1961 authorization requests amendment to $9,000,000.

60-c-13 Experimental organic cooled reactor

Conceptual design by Phillips Petroleum Co. has been completed and final report submitted to the Commission in December 1959. Contract for complete engineering services (including design and inspection of construction) for the project awarded to the Flour Corp. with Atomics-International (as subcontractor to Flour) to provide nuclear assistance. Final design started by Fluor on December 21, 1959. The construction contract is expected to be awarded in March 1960.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$6,000,000
Present cost estimate	$6,000,000
Amount allotted	$6,000,000
Amount obligated	$376,836
Costs incurred	$25,622
Percentage complete:	
Design	5
Construction	0

60-c-14 Experimental low temperature process heat reactor

Sargent & Lundy has been performing design work since August 1959. Title II design began in December 1959 with the activity to date involving mainly the writing of plant component specifications. A site evaluation report was submitted by Sargent & Lundy to the Commission and the Advisory Committee for Reactor Safeguards for consideration.

The reactor supplier proposals received December 7, 1959, have been evaluated and a contract negotiated with Allis-Chalmers for design of the reactor with option for hardware procurement.

Bids for construction of the ELPHR are being evaluated. Invitations for fixed price bids on the containment vessel, overload crane, and heat sink have been issued. Selection is underway for a contractor to perform a small amount of preconstruction R. & D.

Proposed site for location of the reactor (Point Loma (near San Diego), Calif.) is presently held by the Navy. The Commission together with the Department of the Interior are negotiating with the Navy Department for the release of this site. Construction scheduled to be completed in late calendar year 1961. The Commission and the Department of the Interior are negotiating cooperative agreements with the State of California and the city of San Diego, Calif., with respect to their interests in this project. It is expected that these agreements will be executed during March 1960.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	$4,000,000
Present cost estimate	$4,000,000
Amount allotted	[1] $400,000
Amount obligated	$378,000
Costs incurred	$64,286
Percentage complete:	
Design	20
Construction	0

[1] To cover design work and preparation and submission of site evaluation report. Balance of funds not allotted pending agreement and execution of cooperative arrangements with State of California and city of San Diego and availability of Point Loma site.

60–e–15 Power reactor of advanced design capable of utilizing nuclear superheat to be undertaken either as a cooperative project or conducted solely by the AEC

Conceptual design for project performed by General Nuclear Engineering Corp. (a subsidiary of Combustion Engineering, Inc.) under project 59–d–14. Contract for title II design was awarded to General Nuclear Engineering Corp. on February 4, 1960. A contract was signed with the Puerto Rico Water Resources Authority on January 12, 1960, providing for joint participation in the construction and operation of the plant. PRWRA will furnish at their expense the construction site and conventional facilities and will operate the plant for the Commission on a reimbursable basis. A cost-type prime contract will be negotiated for the construction of the nuclear portion of the plant. Construction is scheduled to start in June 1960, completed in November 1962, with design power operation commencing in December 1962. Preliminary hazards report was received by the Commission in January 1960.

Financial data and status of construction as of Jan. 31, 1960

Amount authorized	$11,000,000
Present cost estimate	11,000,000
Amount allotted	[1] 3,000,000
Amount obligated	([1])
Costs incurred	0

[1] $3,000,000 appropriated in fiscal year 1960 covers advance engineering and procurement of long-lead items; the balance of $8,000,000 is included in the fiscal year 1961 budget.

Fiscal Year 1958 Cooperative Power Reactor Demonstration Program

Yankee Atomic Electric Co. (first round)

Contractors.—
Operation: Yankee Atomic Electric Co.
R. & D.: Westinghouse Electric Corp.
Design: Stone & Webster Engineering Corp. (A–E), Westinghouse Electric Corp. (nuclear equipment).
Construction: Stone & Webster Engineering Corp.

Commission support of research and development assistance continuing. Construction work continuing with completion by early fiscal year 1961. The reactor pressure vessel was installed in the vapor container on February 17, 1960.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	[1] $5,000,000
Present cost estimate	$5,000,000
Amount allotted	$5,000,000
Amount obligated	$5,000,000
Costs incurred	$4,778,000
Percentage complete:	
Design	100
Construction	70

[1] Research and development only. Does not include $3,150,000 waiver of fuel use charges.

Consumers Public Power District of Nebraska (Hallam) (first round)

Contractors.—
Operation: Consumers Public Power District.
Research and development: Atomics International.
Design: Atomics International; Bechtel Corp.
Construction: Peter Kiewit & Sons Co.

Research and development work continuing. Study underway to evaluate effects of the SRE fuel element failure on the design of the Hallam nuclear power facility. Supplementary preliminary safeguards report covering the results of this study is being prepared. Design will be modified as required to insure that an incident similar to the SRE fuel incident will not occur at Hallam.

Design and construction on schedule. Pouring of foundations and steel erection is currently underway. Installation of nuclear components is not scheduled

for several months. Construction started April 1959, scheduled to be completed in July 1961, with design power operation commencing in May 1962.

Financial data and status of construction as of Jan. 31, 1960

	Research and development	Construction
Financial:		
Amount authorized	$26,165,000	$24,013,000
Present cost estimated	$26,165,000	$24,013,000
Amount allotted	$21,170,000	$22,249,000
Amount obligated	$20,783,420	$16,693,663
Cost incurred	$11,745,953	$6,468,054
Percentage complete	[1] 80	17

[1] Design.

Fast breeder reactor technology

Construction work on the Power Reactor Development Co. reactor was on schedule and was 60 percent complete on January 31, 1960. Equipment within the reactor containment vessel is currently being mechanically tested. Construction started August 1956, scheduled to be completed by June 1960, with design power operation commencing in June 1961.

Research and development work continued in AEC facilities on the development of fast breeder technology.

Financial data and status as of Jan. 31, 1960

Amount authorized	$3,600,000
Present cost estimate	4,309,000
Amount allotted	1,457,000
Amount obligated	1,339,344
Costs incurred	1,339,344

Rural Cooperative Power Association (Elk River) (second round)

Contractors.—

Operation: Rural Cooperative Power Association.

R. & D.: Allis-Chalmers Manufacturing Co.

Design: Allis-Chalmers (nuclear design); Sargent & Lundy (supporting facilities).

Construction: Allis-Chalmers Manufacturing Co. (prime contractor); Maxon Construction Co. (subcontractor).

Design work has been completed and construction work is currently on schedule. The reactor vessel was shipped from the Pacific Coast Engineering Co. Training of the first group of reactor operators was started in January 1960. All work completed by RCPA on turbogenerator at an estimated cost of $1,750,000. Construction work started in August 1958, scheduled to be completed in November 1960, with design power operation commencing in February 1961.

Financial data and status of construction as of Jan. 31, 1960

	Research and development	Construction
Financial:		
Amount authorized	$2,176,000	$9,397,000
Present cost estimate	$2,176,000	$9,397,000
Amount allotted	$2,176,000	$9,397,000
Amount obligated	$2,176,000	$9,395,903
Costs incurred	$120,343	$3,685,361
Percentage complete	[1] 100	45

[1] Design.

City of Piqua, Ohio (Second Round)

Contractors.—

Operation: City of Piqua, Ohio.

R. & D.: Atomics International.

Design: Atomics International (nuclear); Holmes & Narver (conventional).

Construction: Atomics International.

Title II design and supporting research and development program will be completed in fiscal year 1960. Construction is continuing and all phases of the project are currently on schedule (as modified by the steel strike). Deliveries of containment vessel steel began in January 1960.

Construction started July 1959, scheduled to be completed in April 1961, with design power operation commencing in June 1961.

Financial data and status of construction as of Jan. 31, 1960

	R. & D.	Construction
Financial:		
Amount authorized	$6,818,000	$7,332,000
Present cost estimate	$6,818,000	$7,332,000
Amount allotted	$6,818,000	$7,332,000
Amount obligated	$6,818,000	$7,331,310
Costs incurred	$3,438,000	$1,139,260
Percentage complete	[1] 93	4

[1] Design.

Chugach Electric Association of Alaska (second round)

The Commission has determined that the sodium deuterium reactor technology is not sufficiently advanced to warrant further consideration of construction of this reactor concept.

Financial data as of Jan. 31, 1960

R. & D.:	
Amount authorized	$10,655,000
Present cost estimate	
Amount allotted	2,187,000
Amount obligated	2,187,000
Costs incurred	2,187,000
Construction	9,229,000

Northern States Power Co. (third round)

Contractors.—

Operation: Northern States Power Co.

R. & D.: Allis-Chalmers Manufacturing Co.

Design: Allis-Chalmers Manufacturing Co., Pioneer Services & Engineering Co. (entire plant).

Construction: Allis-Chalmers Manufacturing Co., Fegles Construction Co. (subcontractor).

Research and development work going forward on schedule. Experiments in the critical facility will be well underway by June 1960. Delivery of the superheater fuel for the critical facility will be during the third quarter of fiscal year 1960 and experiments using superheater fuel are scheduled to get underway before the end of fiscal year 1960. Comoponents for the prototype recirculation pump, underwater fuel handling, and prototype pressure vessel head and superheater leg for the heat transfer test facility will be procured during the last half of fiscal year 1960.

Work in fuel element fabrication and nuclear physics analysis will receive major emphasis during the remainder of fiscal year 1960.

Steel for the containment vessel has been ordered. Hearing on the construction permit was held on February 15 and 16, 1960. Site preparation started in November 1959. The plant is scheduled to be completed in January 1962 with power operation commencing in October 1962.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	[1] $8,500,000
Present cost estimate	$8,500,000
Amount allotted	$8,500,000
Amount obligated	$8,310,000
Costs incurred	$3,467,825
Percentage complete:	
Design	10
Construction	0

[1] Research and development only Does not include $1,800,000 for waiver of fuel use charges.

East Central Nuclear Group, Inc.—Florida West Coast Nuclear Group (third round)

Contractors.—

Operation: Florida West Coast Nuclear Group.

R. & D.: General Nuclear Engineering Corp., American Electric Power Service Corp., and others.

Design: General Nuclear Engineering Corp., American Electric Power Service Corp.

Research and development work progressing satisfactorily. Test of fuel bundles is to start about May 1960. Decision as to construction is expected to be made late in calendar year 1960.

Financial data as of Jan. 31, 1960

Financial:	
Amount authorized	[1] $11,646,000
Present cost estimate	$11,646,000
Amount allotted	$11,646,000
Amount obligated	$8,097,000
Costs incurred	$609,000
Percentage complete:	
Design	0
Construction	0

[1] Research and development only. Does not include waiver of fuel use charges, $910,000; and waiver of D_2O use charges, $624,000.

Carolinas-Virginia Nuclear Power Associates, Inc. (third round)

Contractors.—

Operation: Carolinas-Virginia Nuclear Power Associates, Inc.

R. & D.: Westinghouse Electric Corp.

Design: Westinghouse Electric Corp.

Architect-engineer for plant: Stone & Webster Engineering Corp.

Construction: Stone & Webster Engineering Corp.

Research and development work is continuing and is about 25 percent complete. Completion of the critical experiment by Westinghouse will be set back by 2 or 3 months because of a delay in fuel fabrication. It is anticipated that these experiments will be initiated April 1960. Hearing on construction permit was held on February 23, 1960. Westinghouse has applied for a license to operate the critical facility. Construction is scheduled to start in April 1960, completed in June 1962, with power operation commencing in November 1962.

Financial data and status of construction as of Jan. 31, 1960

Financial:	
Amount authorized	[1] $13,905,000
Present cost estimate	$13,905,000
Amount allotted	$13,905,000
Amount obligated	$11,617,000
Costs incurred	$2,466,000
Percentage complete:	
Design	5
Construction	0

[1] Research and development only. Does not include waiver of fuel use charge, $750,000; and waiver of D_2O use charge, $420,000.

Small pressurized nuclear power reactor (second round)

Contract awarded in August 1959 to Gibbs & Hill, Inc., for conceptual design with option for title I and title II design of the reactor plant. Five proposals received from cooperatives and public-owned utilities for operation of the plant are currently under review by the Commission and proposals from six manufacturers for the reactor were received on February 1, 1960. Invitations for construction contractor proposals for nuclear facilities were issued on February 5, 1960, with award expected to be made in April 1960. Construction is scheduled to start in June 1960, completed in August 1962, and power operation commencing in October 1962.

Financial data as of Jan. 31, 1960

Amount authorized	$12,000,000
Present cost estimate	12,000,000
Amount allotted	[1] 1,000,000
Amount obligated	85,000
Costs incurred	0

[1] Represents title I and title II A–E work. Balance of funds to be allotted upon approval and execution of a cooperative agreement.

Intermediate size (50 MWE) boiling water reactor (second round)

Invitation to utilities to provide the conventional portion and to operate the entire plant was issued on January 8, 1960. The invitation to industry for development, design, fabrication, and construction of the plant was issued on January 15, 1960. Proposals on both invitations are due April 16, 1960.

Financial data as of Jan. 31, 1960

Amount authorized	$13,000,000
Present cost estimate	13,000,000
Amount allotted	0
Amount obligated	0
Costs incurred	0

Intermediate size organic reactor (not less than 50 MWE) (third round)

Invitations to privately, publicly and cooperatively owned utilities for proposals for the development, design, fabrication, construction, and operation of a prototype nuclear powerplant, incorporating an organic-cooled and moderated reactor, was issued on January 22, 1960. Proposals are due May 2, 1960.

Consumers Power Co. of Michigan (unsolicited proposal)

Proposed contractors.—
Operation: Consumers Power Co.
R. & D.: General Electric Co.
Design: General Electric Co.
Construction: Bechtel Corp.

Unsolicited proposal of Consumers Power Co. of Michigan and General Electric Co. to build and operate a boiling water, high-power density, prototype nuclear powerplant project (50 MWE) has been accepted by the Commission on January 7, 1960, as a basis of negotiations for research and development assistance under third round terms. Preliminary negotiations are in progress. Construction is tentatively scheduled to begin in the summer of 1960, with first criticality in late 1962.

Philadelphia Electric Co. (third round)

Contractors.—
Operation: Philadelphia Electric Co.
R. & D.: General Atomic Division (General Dynamics Corp.).
Design: Bechtel Corp., General Atomic Division (General Dynamics Corp.).
Construction: Bechtel Corp.

Research and development work continuing. Revised preliminary site evaluation report was completed and presented to the Commission in January 1960. Construction of the high temperature gas reactor critical assembly underway. Construction of the plant at Peach Bottom, Pa., is scheduled to start in April 1961, completed in October 1963, and power operation commencing in early 1964.

Financial data and status of construction as of Jan. 31, 1960

Research and development:	
Present cost estimate	$14,500,000
Amount authorized	[1] 14,500,000
Amount allotted	14,500,000
Amount obligated	14,500,000
Costs incurred	3,028,342

[1] Does not include $2,500,000 for waiver of fuel use charges.

Representative HOLIFIELD. General Luedecke, will you come forward, please?

Mr. LUEDECKE. Thank you, Mr. Chairman.

Representative HOLIFIELD. On the bill we have page 2 which has to do with special nuclear material for atomic weapons.

Do you have an unclassified statement to make on that or would you prefer to hold this until we have our executive session and start on page 3.

Mr. LUEDECKE. There are short statements that can be made on those, sir.

Representative HOLIFIELD. Very well. Will you proceed?

SPECIAL NUCLEAR MATERIALS PROGRAM

Mr. LUEDECKE. Projection 61–a–1 through 61–c–2 with two exceptions fall into this category in which the detailed justification will need to be given in closed session. Project 61–a–1, modification to production and supporting installations, $10 million. This is the same type of project that you have been familiar with in previous budgets and provides for modification and construction of facilities related to program changes and technological developments in the production program.

Progress made in development, coupled with changes in the requirements, indicates a need which cannot be specifically identified this far in advance to assure continuity of operations, increased productivity, increased safety, and provide for economical operation of production and supporting facilities. This project includes the design, procurement, fabrication, and installation of equipment, and construction work under the Oak Ridge, Hanford, and Savannah River operations offices. While they are not programed against specific projects, some illustrations of the type of work that might be done under this project are facilities for production of new fuel elements, reactor modifications to accommodate these new fuel elements, new effluent systems, the reduction of radiation exposure, heavy water conservation, and underwater fuel element examination facilities. This is a figure that is derived primarily from experience.

Representative HOLIFIELD. Mr. Ramey has a question.

Mr. RAMEY. You mentioned that part of that money might be used for facilities for fuel elements for production reactors.

Isn't this possibly a type of activity that might more appropriately and possibly even more economically be done in private facilities?

Mr. LUEDECKE. This would not be for the production of those particular fuel elements. There is a project in here, I believe, Mr. Ramey, that answers your question.

I think the answer in this case is "No."

Representative HOLIFIELD. You speak of reduction of radiation exposure. Is that of radiation exposure at existing facilities, or at some of the new facilities?

Mr. LUEDECKE. This would refer to the likelihood that we will need to make some modifications to existing structures. Our study has not indicated yet that this is necessary, but we believe it probable.

Representative HOLIFIELD. Does that have anything to do with the reduction of radiation standards?

Mr. LUEDECKE. No, sir.

Representative HOLIFIELD. Very well, will you proceed?

Mr. LUEDECKE. Project 60–a–2, billet production plant, $1,800,000. This project provides for the necessary metal production capability for fabrication for the Hanford new production reactor (NPR). It may be possible to accomplish this by modifying and expanding the existing plant at Fernald. If not, then a new building will be built, either at Fernald, or some other Commission site.

In any event, a modified facility will require equipment for three major process steps: Reduction, recasting, and machining, with necessary support services. Since the first reactor loading of the NPR will be required late in calendar year 1962, and since the initial equivalent quantity of slightly enriched uranium billets will be required by early fiscal year 1962, the construction of this facility must begin in fiscal year 1961. This project is a contingency against being able to procure the NPR billets from commercial sources. Proposals are soon to be solicited from industry for the NPR billets. But as the success of the commercial procurement action cannot be guaranteed, we feel that the funds should be available on a contingency basis.

I believe this would answer the question raised by Mr. Ramey.

Project 61–a–3, $2,500,000, heat treatment and inspection modifications, Fernald, Ohio. This project provides for the modification of existing fuel element fabrication facilities at Fernald, including such items as building additions and their modification, purchase of new equipment and relocation of existing equipment to permit process changes in the heat treatment and inspection facilities for the fuel elements.

The requirement for modification and addition arises from a need for heat treating, inspection and machining facilities designed specifically to meet the more rigid specifications, and to provide some flexibility for coping with expected future changes in metal specification.

Besides a building addition of approximately 48,300 square feet, this project will include relocation and alteration of existing utilities, construction of additional roadways, and related work. The specific requirements for that can be covered in closed session.

Project 61–a–4, development laboratory building at Oak Ridge, $766,000. This project will provide for the construction of a laboratory-type building having approximately 24,000 square feet gross area. The new building is needed to replace a wartime structure which is inadequate for the requirements of present and future process development programs at the Oak Ridge and Paducah gaseous diffusion plants.

The building now used for this purpose is an old wartime structure that has been there since the operations began. It is no longer adequate to accommodate the equipment and is a definite fire hazard.

Project 61-a-5, plutonium reclamation plant at Hanford, Wash., $2,900,000, will provide a new improved facility for reclamation of plutonium from both the wet and dry wastes which originate in the plutonium purification and fabrication operations. The present facilities are not adequate in terms of capacity and there is a matter of safety.

Project 61-a-6, moderator purification improvements, Savannah River, $2,500,000. This is to provide for improvements and additions to the moderator purification facilities in each of the five Savannah River reactor areas. The facilities will be designed to reduce the amount of particulate matter generated in the moderator coolant and to reduce the turbidity in the moderator by removing radioactive particles.

WEAPONS PROGRAM

Representative HOLIFIELD. We will omit the atomic weapons section. We will take that up with some additional questions on the items you have explained in tomorrow's executive session. We will go right to page 3 of the bill. Project 61-d-1.

REACTOR DEVELOPMENT PROGRAM

Mr. LUEDECKE. Project 61-d-1, additions and modifications to the chemical engineering building, Argonne National Laboratory, $2 million. This will provide for the addition of a wing to the chemical engineering building at Argonne. It will permit an expansion of the programs in the areas particularly of pyrometallurgy, the high-temperature processes and materials, plutonium and fluorine chemistry, as well as to provide a facility for housing of the gamma analyzer facility. This proposed building is 27,884 square feet and is just a straight-wing addition to the existing chemistry building which was completed in late 1950.

Representative HOLIFIELD. Is this or is it not a process that would lend itself to private industry?

Mr. LUEDECKE. This is strictly chemistry development work. It is the same kind of work that they are doing in carrying forward the development and design of the EBR-2. I do not believe it lends itself to private industry.

Representative HOLIFIELD. One of the purposes is to provide space for industry training.

Will industry pay for that training or is this a free service for the training of these industry people?

Mr. LUEDECKE. I am sorry, I don't know the answer to that specific question.

If I may, I will provide it for the committee.

Representative HOLIFIELD. Very well.

(The information referred to follows:)

PROJECT 61-D-1—ADDITIONS AND MODIFICATIONS TO CHEMICAL ENGINEERING BUILDING, ARGONNE NATIONAL LABORATORY, ILLINOIS

The proposal to train industrial representatives is consistent with AEC's normal policy for training scientists from industrial power groups in our national laboratories to receive experience since industrial concerns do not have adequate facilities.

The organizations furnishing individuals to the Laboratory pay all salaries, travel to and from the Laboratory, and other normal personal expenses, however, should an individual travel at the request of the Laboratory, the Laboratory pays the bill.

The Laboratory provides working space for the individual and uses him as one of its staff for the duration of his stay. This arrangement supplements the Laboratory in a very useful way, especially if the individual is assigned to the Laboratory for a long period of time, such as approximately a year.

Representative HOSMER. What square footage did you say this involved?

Mr. LUEDECKE. 27,884 square feet.

Representative HOSMER. Most of this $2 million cost is going into the gamma analyzer facility?

Mr. LUEDECKE. The square footage included the area for the gamma analyzer. The project includes costs for the gamma analyzer.

Representative HOSMER. Thank you.

The reason I ask you is that your laboratory construction cost you told us last year ran about $32 a square foot. And this other one you have in here is $31.50 a square foot.

Mr. LUEDECKE. This would run $22.95 per square foot of construction.

Representative HOSMER. Thank you.

Representative HOLIFIELD. You may proceed.

Mr. LUEDECKE. Project 61-d-2, special purpose test installation addition, Santa Susana, Calif., $1,200,000. This project provides testing capability for advanced high-power reactors, for use in advanced space mission requirements of NASA.

As mentioned this morning by Colonel Armstrong in connection with SNAP unit, this is one of the facilities we would be requesting and in keeping with the discussion with the staff we plan to make a full presentation on this in closed session.

Representative HOLIFIELD. That will be financed by the AEC rather than NASA?

Mr. LUEDECKE. This facility would be financed by the AEC. It is required for a reactor development.

Representative HOLIFIELD. The research and development would probably be paid for by the NASA agency if it was contract work for them.

Mr. LUEDECKE. No, sir. This is a development pursuant to the Commission's responsibility.

Project 61-d-3, technical space for SPERT, National Reactor Testing Station, Idaho, $500,000, is a project to provide additional necessary facilities for the reactor safety program project and will provide laboratories and space for technical personnel. The continued growth of the special power excursion reactor test (SPERT) program has resulted in an assembly of a staff of approximately 60 operating personnel.

The staff is concerned with operational planning and experimental equipment preparation, reactor operation, conduct of special experiments, and initial accumulation and reporting of results.

The functions involve administrative, operational, laboratory, data reduction and processing, engineering, and communications activities.

The existing SPERT control center comprising a total of 8,000 square feet, in addition to providing control facilities for the four

SPERT reactors, houses laboratory space for instrument and mechanical assembly work, darkroom, counting room, data reduction facility, and office space.

The office areas have a space allowance of only 45 square feet per person and the other areas are equally crowded. Within the next 2 years the staff is predicted to reach approximately 110 employees, including those necessary to carry out the SPERT 4 operational and testing program. In order to meet the needs of increasing staff and to provide adequate facilities for the present staff, the additional staff space must be provided. The additional space would be 10,000 square feet and would raise the square foot per person available to 61 square feet per man.

Representative HOLIFIELD. These SPERT programs are really geared directly to the safety program and you deliberately run these reactors at excessive levels in order to see what the materials will stand; is that not true?

Dr. PITTMAN. Yes, sir. These are safety experiments that are run solely for the sake of getting information that is useful and necessary in determining the safety factors of these reactors.

Mr. LUEDECKE. Project 61–d–4, critical building, Brookhaven National Laboratory, $600,000.

The Brookhaven National Laboratory engages in reactor physics work and advancing core technology of benefit to the various reactor development concepts. This project will provide approximately 10,000 square feet and will contain a shielded critical assembly cell control console room and necessary support area including a low-level counting room.

This facility is required to permit Brookhaven National Laboratory to develop reactor physics information for use in the design of advanced reactor cores. The growing importance of highly inhomogeneous cores in the AEC power reactor program now requires a more orderly study of their characteristics than has been possible in the past. Such work, including work on the multiple-zone cores and spiked cores, is planned by Brookhaven Laboratory.

The experimental areas in Brookhaven are inadequate primarily because highly complex cores are not amenable to accurate experimental study in the Brookhaven National Laboratory exponential facilities. This difficulty becomes very severe for the exponential experiments on multiple-zone loaded or spiked cores due to the complex interpretation of the traverse flux distribution. This renders the exponential experiment technique worthless when the core's geometry also includes actual nonuniformity.

Therefore, there is a current need for the requested critical facility at Brookhaven National Laboratory.

Representative HOLIFIELD. You actually design reactor cores and test them in this facility.

Dr. PITTMAN. No, sir; this is not a facility for the design and test of specific reactor cores for specific reactors. It is, rather, a critical assembly in which you can study the physics of various core configurations. It is absolutely necessary that we begin to learn more and more about the physics of these cores that are zoned with different concentrations of U–235 in different parts of the cores, or spiked cores, because all of this is necessary to give us the long burnouts we must

achieve if we are to have economic power. It is not designed for specific cores for specific reactors. It is to get physics data.

Representative HOLIFIELD. For all reactors?

Dr. PITTMAN. Yes, sir. It applies to all the cores that will be used in the various reactors that will be built, but not specifically for any one.

Mr. LUEDECKE. Project 61–d–5, fast reactor core test installation, Los Alamos Scientific Laboratory, New Mexico, $6,900,000. This project would provide an installation for the test operation of new types of fast spectrum power reactors intermediate in power level. This installation will be capable of testing reactors at heat outputs of up to 20 megawatts. It will be equipped for final assembly, operation and for post operational disassembly of the reactor.

The project includes building construction and fabrication and installation of LAMPRE II, a 15 megawatt reactor that is planned to start operation in early fiscal year 1963, 2½ years after LAMPRE I starts operation at power.

The building will be designed and constructed so that a succession of different core concepts can be studied with a minimum rearrangement of the main plaint. With present facilities, LASL is limited to reactor experiments with a maximum power level of about 1 megawatt.

This situation will be partly relieved by the completion of the power reactor test building which is scheduled for completion in February 1960.

The experimental engineering and fabrication facilities of this building will be used to develop, construct and instrument the core and blanket proportions of the LAMPRE II reactor.

The LAMPRE II reactor installation is considered to be an essential intermediate step between LAMPRE I, which primarily provides nuclear and fuel handling information, and a large scale prototype power producer of 60 to 300 megawatts heat output. The LAMPRE II is planned to operate at about 15 megawatts heat output and to demonstrate all the essential functions of a full-scale plant except the production of electric power. The functions include liquid fuel handling, fuel processing, breeding blanket operation, dynamic control, extreme purity sodium and gas systems, steam generating, core renewal and waste disposal.

One of the prime problems in the design of the fast breeder cores is the attainment of high specific power and power density.

Another problem is the development of liquid fuel container materials and the fabrication methods suitable for the necessary high temperature and heat flux. Because of the relationship of the core critical size and the heat transfer capacity, the small 1 megawatt scale of reactor experiment cannot yield information on high performance core design.

At the other extreme, full scale cores have high costs for critical material and auxiliary plant. The scale of the LAMPRE II is judged to be the optimum choice for advancing development of fluid fuel fast breeder reactors.

Representative HOLIFIELD. This will be beneficial to all types of fast breeder reactors.

Dr. PITTMAN. This system, Mr. Holifield, is being developed to allow Los Alamos to pursue really only one type of fast breeder and that is the molten plutonium type. The information that comes from this facility, therefore, should be limited to the molten plutonium reactor facility.

It is perfectly obvious that information about the use of molten plutonium as a fuel will be useful to our fast breeder program.

Mr. LUEDECKE. Project 61–d–6, plutonium fuel service and development building, Los Alamos Scientific Laboratory, New Mexico, $600,000. This project provides for an addition to an existing facility at Los Alamos Scientific Laboratory for the purpose of fabricating fuel components of complex alloys suitable for large reactor experiments such as the Los Alamos molten plutonium reactor experiment, LAMPRE.

Laboratory work is being planned to conduct investigations on the possible uses of plutonium as a reactor fuel in forms other than alloys. Such investigations will include plutonium graphite, plutonium oxide, cermets, and possibly plutonium carbide. To date it has been possible to carry out small scale alloy-fuel development and to furnish the LAMPRE program with test alloys using existing metal fabrication facilities. Space at DP West, TA–21, has also been made available for loop tests and other experiments. More laboratory experiments and more complex alloys suitable for the large reactor of the LAMPRE type will preclude the use of the present fabrication line facility and will require additional space in which to fabricate fuel components for various tests and criticality experiments for the expanded experimental program.

Additionally equipment to carry out fabrication and processing is not available in any of the existing facilities. Therefore in order to continue a well-planned experimental reactor program, involving plutonium fuels, additional space and equipment will be needed.

Representative HOLIFIELD. We will pass over 61–d–7 and 61–d–8 and take them up in the morning in executive session.

Mr. LUEDECKE. All right, sir.

FOOD IRRADIATION PROGRAM

Representative HOLIFIELD. At this time, General Luedecke, Mr. Van Zandt is here and he had some questions which he wanted to ask Mr. McCone, I believe.

Mr. McCone, will you please come back to the chair so we can continue this testimony?

Mr. MCCONE. Yes, sir.

Representative HOLIFIELD. Is Dr. Aebersold here?

Dr. AEBERSOLD. Yes.

Representative VAN ZANDT. Project 59–g–3 on page 10 of the testimony has to do with the process irradiator. When the Joint Committee held its public hearing on the Army cancellation and cutback in the food irradiation program last January, an ad hoc panel report of the Interdepartmental Committee on Irradiation Preservation of Food was discussed at the hearings. The report consists of a number of recommendations, including that the AEC be designated as the operating agency for national civilian process food program. The

report was adopted according to my understanding by the interdepartmental committee on February 12. Am I right in my understanding?

Mr. McCone. That is correct, as I understand it.

Representative Van Zandt. What is the status of the report at the present time? What action has the Commission taken in furtherance of the recommendations?

Mr. Luedecke. When the report of the interdepartmental committee was received by the Commission, the staff evaluated the report and made its recommendations to the Commission for a food irradiation program. The Commission has now approved the recommendations of the staff for a food irradiation program and the committee is being advised of this by letter tomorrow.

Representative Van Zandt. To date has the AEC prepared any kind of study as to the required organization and the people it will need to operate the program?

Mr. McCone. Not specifically. As you are aware, the interdepartmental committee recommended that the AEC take over management of the program and made some suggestion as to what it should include. Insofar as a specific organizational structure within the Commission to carry out the program is concerned, we have done that with respect to the program we are recommending but not with respect to the full program recommended by the committee.

Representative Van Zandt. General, on page 23 of the ad hoc panel report, the following two budgetary problems are listed: I am going to read from the report.

> Due to the budgeting cycle it would not be expected adequate operating funds will be available for the civilian radiation process foods program before fiscal year 1962.
>
> Second, assuming the Army arrives at a decision or other arrangements are made to proceed promptly with the construction of a research and development radiation center for food processing it would not be available for use before fiscal year 1962. If the center must await the customary budgeting process it would not be available for use until fiscal year 1964. Thus 2 years can be saved if the center can be undertaken promptly.

If the AEC becomes the operating agency, as the interdepartmental committee has recommended, what actions can you take to overcome these long lags in leadtimes caused by the budgeting process?

Mr. Luedecke. The program that the Commission has approved would provide during fiscal year 1960 $115,000 to get started on the basic research aspects of the program. It would provide in fiscal year 1961 out of currently budgeted funds $500,000 for the procurement of two portable radiation facilities and for the continuation of these basic programs. It does not provide in those same years for a center in the sense that a center is covered in the committee's report.

Representative Van Zandt. General, the ad hoc panel in the report listed its budget estimates, and I am quoting from pages 24 and 25, for operating cost figures with $400,000 for fiscal 1960 and $920,000 for fiscal 1961.

Mr. Luedecke. That is correct, sir.

Representative Van Zandt. Then the figures you gave us a moment ago are certainly less than the figures I read.

Mr. Luedecke. They are; yes, sir. We felt that the program as recommended by the interdepartmental committee was larger and went into the problem faster than we felt was indicated in light of what we know about the food-irradiation effects.

Representative VAN ZANDT. One of the things that impressed me about this report was that it was unanimous. Of course, the Commission is taking a different position than the report recommends.

Mr. LUEDECKE. Yes, sir; that is correct.

Representative VAN ZANDT. Do you think that the figures that you have given us, that is, the amount of money you have mentioned, is adequate to support this program at the level it should be supported?

Mr. LUEDECKE. We believe it is, sir. This is without regard to what the Army may do with respect to high-level irradiation. We believe it is adequate as an effort in the low-level irradiation field, and that it attacks the basic problems instead of placing the money in irradiation facilities as recommended by the committee.

Representative HOLIFIELD. If the gentleman would yield, as Mr. Van Zandt has pointed out, this is going to slow up the program even below that which your interdepartmental committee recommended. This is another instance of dragging out a program for budgetary reasons, is it not?

Mr. MCCONE. No; I don't think that can be said, Mr. Chairman. The Commission considered this matter and they felt that it was necessary to answer certain series of very fundamental questions in connection with the irradiation of food before an intense research program, and more particularly a program of production, went forward. We felt, and it was the recommendation of the staff and the Commission concurred, that this level of effort would produce a satisfactory result.

Representative HOLIFIELD. Dr. Aebersold was on the staff, and he certainly made no dissent to the report. He was the chairman of it, it, I believe. He made no dissent to the original report—did you, Dr. Aebersold?

Mr. AEBERSOLD. Maybe I could clarify something here.

First of all, the Army has not definitely canceled plans to go ahead with a research center on food irradiation. They delayed a pilot plant to produce very large quantities for feeding troops because they felt there was a need to study the logistics and the wholesomeness further. They are still keeping active the contract which the AEC is administering for the design and construction of an experimental facility which would use cobalt 60. Instead of being a hi-fi, as it was designed for Stockton, it would be a more flexible facility not intended for the pilot production of food but for trying all different kinds of shapes of packages and process variables.

Representative HOLIFIELD. What happens to this facility at Stockton which you already had established? I don't remember how much money was spent on that. Was it just designed?

Mr. AEBERSOLD. It was only design. There was no construction, there was no operator. It was only in the planning stages. It was conceived with the idea of having sufficient leadtime to build it if all the other research and wholesomeness tests fitted as planned.

If everything came out as planned, then the construction of that would be finished at a time when they were ready to undertake large-scale feeding and supplying of troops. These hopes did not come out. So they decided to go back to a more research and development program and kept alive a design of a research facility. The facility will still use around a million curies of cobalt but the cobalt would be in rods that could be shifted around to try all different kinds of

arrangements for irradiating food, rather than the large fixed plaques that were in the Stockton facility which would be for turning out specific size Army packages, V–2 packages, at a certain rate per month. They have thus gone back to a research program, but the research center design is still alive.

Representative PRICE. Doctor, is it considered essential in order to prove out this theory of irradiation of food that a pilot plant such as the one that was planned at Stockton be constructed? This is not for production purposes. This is for research purposes.

Mr. AEBERSOLD. At the start of the program, an entire program of 5 to 8 years was planned, including the wholesomeness studies which they knew would take 3 to 5 years. They believed if the wholesomeness tests were completed at the end of 1962 they would need a pilot production facility.

Representative PRICE. Let us keep it separate from production.

Mr. AEBERSOLD. I mean a pilot plant facility. We still have active for the Army the design of a facility for research. It is my understanding from the Army at this moment that if their appropriation permits it they will build a research center. The AEC has Army funds given to us which are sufficient to cover construction. The Army has to budget, however, for the operation of such a research center.

Representative PRICE. I think it would be well, Mr. Chairman, that we get in one spot a picture of what program we have going at the present time and what they plan to do. What do you have going now at the present time?

Mr. AEBERSOLD. We are in the process of preparing a full statement on the AEC's proposed program and its relationship to the Army's program. The interdepartmental committee will meet again March 15, at which time each agency will be prepared to say what role they will take in the overall food program.

At that time I think we can put together a complete picture of the irradiation facilities and the type of program to be carried out both at high and low radiation dose levels. These are not competitive programs. They are mutually complementary. I think when we have time to work this out in the next week or two we will have a very excellent program covering both civilian and military requirements.

Representative PRICE. A moment ago the chairman or General Luedecke said that the Commission had given tacit approval to the report of the intergovernmental committee. What did you mean by that? What type of approval did you give and how far did you go in the approval of the report?

Mr. LUEDECKE. I think I said the Commission has approved a program as the result of this report by the interdepartmental committee. The program that the Commission has approved is not the same program as put forward by the committee.

Representative PRICE. How far did you go along with the report? To what extent did you support it?

Mr. LUEDECKE. To the extent in 1960 of $115,000.

Representative PRICE. As against what recommendation of the committee?

Mr. LUEDECKE. As against $400,000, I believe. And $500,000 in 1961. The major significant change or the major significant differ-

ence in the program that the Commission has approved and the one recommended by the committee is that we do not procure all of the irradiation that they recommend, nor do we start financing a radiation center as they have recommended.

Representative PRICE. Did the committee make any recommendations on the irradiation source to be adopted?

Mr. LUEDECKE. They did, sir.

Representative PRICE. Who would have jurisdiction over this, the Commission or the Army?

Mr. AEBERSOLD. The history of the irradiated food program is that the AEC has been responsible for advising the Army on radiation sources, particularly those produced from nuclear sources like cobalt or fission products and fuel elements. We still maintain that responsibility with respect to the Army program.

Representative PRICE. Does any definite action have to be taken now by either the Commission or the Air Force or the Army in regard to setting up a radiation source for the program?

Mr. AEBERSOLD. We hope to hear from the Army within the next week or at least by March 15 whether they are going to go ahead with their research center.

Representative PRICE. What would be their part in the program?

Mr. AEBERSOLD. They supply the funds. They have supplied the funds for research and development on the cobalt 60 source as well as design and construction of the research center. The Army will also operate the center.

Representative PRICE. The source would be cobalt?

Mr. AEBERSOLD. Cobalt 60, yes.

Representative PRICE. How big a machine would this require?

Mr. AEBERSOLD. It would be about a million curies of cobalt. The size of the chamber is perhaps 20 or 30 feet long and 10 or 15 feet wide and the concrete shielding around the irradiator is several feet thick. It will cost about a million and a half to $2 million depending on how much food handling facilities are put with it. The irradiation facility itself will cost around a million and a half.

Representative PRICE. Do you know whether or not the Army is close to making a decision in this area?

Mr. AEBERSOLD. I called up the office of the Director of Research and Development of the Army yesterday and they said they would have a decision in time for the March 15 meeting of the Interdepartmental Committee.

Representative PRICE. Do you know whether or not they plan to install this source at Sharp General Depot?

Mr. AEBERSOLD. I understand that the need for a facility at Stockton no longer exists. They are interested in four items of food, mainly meat. These are beef, pork, poultry, and ham. Therefore, the need to be in California near all supplies of fruit, et cetera, does not seem to exist. They are now considering whether to put the facility in Chicago near the Food and Container Institute which has taken a major part in this program or the Quartermaster Depot in Massachusetts where they have their other quartermaster research programs. That decision is still not made.

Representative PRICE. If Mr. Morse does not give his approval to this recommendation, what happens to the overall program?

Mr. AEBERSOLD. I understand they will continue to carry on the wholesomeness program. This is vital to civilian use, the European program, and all the others who are dependent upon the U.S. Army to conduct and complete the full wholesomeness program that they undertook. The Army's wholesomeness program includes 21 food items. The Army intends to concentrate available money on research and development on the limited number of food items which I mentioned earlier. With a much smaller budget they can carry out a very active program on the particular food items.

Representative PRICE. Do you know what the Army budget is now in the food irradiation program?

Mr. AEBERSOLD. I would have to supply that information, sir.

(The information referred to follows:)

Army—fiscal year 1960 budget for food irradiation program

Research and development	$1,175,000
Wholesomeness program	1,050,000
Quartermaster Radiation Planning Agency operation	83,500
Total	2,308,500

Representative PRICE. If you get an adverse decision from the Army on the source, percentagewise, what is the effect on their program?

Mr. LUEDECKE. Maybe I can clarify it.

Representative PRICE. Is it 50, 25, or 90 percent?

Mr. LUEDECKE. Maybe I can clarify that a bit. The Army program, as you know, is directed toward high-intensity radiation for a large quantity of food for troop use. The Interdepartmental Committee that considered this made their recommendations about a low-level radiation program. The irradiation facilities for this low-level program can be achieved in a number of ways, such as by building mobile facilities, which we would propose to include in our program or by modification of the facility at Brookhaven. The Army's facility would not be an essential element for carrying out the low-level program as recommended by the Committee.

Representative HOLIFIELD. It might not be essential but it certainly would be convenient, would it not?

Mr. LUEDECKE. If they already had it I am sure we would use it.

Mr. RAMEY. Was it not thought possible to adapt those facilities? Wasn't there a report prepared that stated it would be possible to adapt the Stockton facility for your low-level research and some of the high-level work, also?

Mr. AEBERSOLD. Yes, sir. The panel report is based upon use of a facility built by the Army. You will note that the report indicates that for the full program to go ahead at the desirable speed the Army should build its research center.

A facility that can be used for high-dose research, also can be used for low-dose studies. However, the amount of food you turn out is 10 times greater and we would not need those quantities for any type of civilian testing program at present. The wholesomeness program on items of interest in the civilian program like fish and fruit has not been conducted. It will take about 2 years to complete the tests and analysis before human feeding studies could go forward on items of food of interest to civilian consumers.

Mr. RAMEY. It would take a year or so to construct the facility, would it not?

Mr. LUEDECKE. About 18 months.

Mr. RAMEY. That would just about fit, would it not?

Mr. AEBERSOLD. There is one other thing the committee should know. At Brookhaven we have obtained an authorization in our 1960 budget for a high-intensity radiation development laboratory. This was not designed for food. It was designed as a development laboratory to consider irradiation of surgical and medical supplies, plastics and chemical studies. This facility can be adapted for certain limited studies in food and it can be used for source development. We can learn how to handle a million curies of cobalt and cesium in this Brookhaven facility. If construction starts as we hope it would in about July of this year, that facility would be available 18 months later, or early in 1962, and could irradiate rather large packages of food. The only difficulty is that we are not sure that the same food items are available in fresh supply all during the season at Brookhaven.

It was not intended as a major food irradiation facility.

Representative PRICE. Several years ago there was great optimism on this food irradiation program. The Army went into it with both feet and plans were made for the research center and the necessary machinery to continue the research program in food irradiation. Are all these changes in the program due to the fact that things have not jelled at the research level as was anticipated and the optimism has died down and you don't see as much use for food irradiation as you did 5 or 6 or 7 years ago, or have you just met with a series of failures in research? Why the change in emphasis on the program?

Mr. AEBERSOLD. It depends on who you talk to. Certain people who are close to the program tell us that even at the sterilization doses certain food items will be preserved for long periods of time, lasting for years without refrigeration, and they are still wholesome and they still are acceptable. The definition of acceptability is difficult to define. One person's taste will be different than another. If the food is cooked with seasoning or prepared in ways for the table, they tell me that it is very difficult to ascertain that the food has been irradiated.

In the case of low-dose treatment which we are considering, doses of about one-tenth as great, that is, half a megarad rather than five, I am told the changes in flavor and texture and color are imperceptible. In other words, the food is much more in its freshlike condition than from any other type of processing, such as cooking, freezing, and so forth.

Representative PRICE. These were all obstacles that you have been faced with ever since you have been in the program. You anticipated and knew all these things. Now you get down to the point that you are so discouraged that you need less research than you did 5 years ago.

Mr. AEBERSOLD. Sir, I am not discouraged. I think certain items that the Army has not looked at very thoroughly, such as fish and fruits, have much more potential for civilian marketability than the items that the Army was looking at, such as meat. The Army did run into problems at the high dose treatment of meat. There were significant changes in the flavor of beef. This depends on the batch

of beef. Some steaks could be treated with five megarads, kept unrefrigerated for long periods, and people could not tell whether they had ever been irradiated. Others would say that on certain batches of steak you could notice a flavor change. They are still investigating why there are these differences—is it due to fat content, differences in the feeding of the cattle, or other variables—to find out why some batches of food hold up very well under irradiation and others do not? That is still their basic problem.

Representative PRICE. Now you need less tools and less support for the program to get these answers than you did 5 years ago?

Mr. AEBERSOLD. We are not judging the Army program; we are discussing the civilian program.

Representative PRICE. We are interested in the overall program. It just happens that the Army has taken the leadership in this area. That is how they became involved in it. We as a committee hold no brief for which agency develops the program or conducts the research.

Representative HOSMER. Dr. Aebersold, isn't there more or less a freezing process under study, too, that has to do with a quick freezing and vacuum extraction of liquids of the material to be preserved and holding it at regular temperatures and so on?

Mr. AEBERSOLD. Yes, sir; for military supplies. Canning, of course, is still one of the best. Dehydration, freezing, and the one you mentioned of freezing plus dehydration are all being investigated. But they all have their limits. In the case of freezing and dehydration together, you have the problem that it won't work for thick pieces of food. Dehydration works for thin pieces of potato, but it won't work for a whole piece of beef. Radiation works very well on thick parts or packages where you need the penetration.

Representative HOSMER. In other words, there is competition among approaches to this thing that we must bear in mind.

Mr. AEBERSOLD. That is right. In the civilian program we are thinking of extending shelf life for a matter of a week or 2 weeks so that freshlike products can be delivered inland from sea coastal areas, such as fish, or so fruit could be shipped from California or Florida to eastern markets. If you could extend the life for 3 days it would make a difference in the marketing of berries.

Representative HOSMER. Thank you.

Representative VAN ZANDT. Let me see if I can summarize this discussion. As I understand it, the food irradiation program is on a reduced basis.

Mr. AEBERSOLD. I can say this: It has been 4 months since the Interdepartmental Committee first met on this problem, so that 4 months has gone by. We could not spend $400,000 at this point of fiscal year 1960. We thought we might if we had an OK on the program several months ago. Therefore, I think the level is about what we can use this year. The question of next year's funds we really cannot tell clearly until we do the startup studies which we will start doing this year. We are having studies made of what kind of irradiators are needed, what kind of products need to be irradiated and to put the framework on a research program for civilian food items.

Representative VAN ZANDT. With the program on the level you have described, you are now waiting on a report which you anticipate in the middle of next week. Do you think the Joint Committee will

have a copy of that report so we may consider it during the course of these hearings on authorization?

Mr. AEBERSOLD. The Interdepartmental Committee is meeting March 15. How soon thereafter another revised report will be made I can't say at this time. It depends on how much unanimity there is in the overall program.

Mr. LUEDECKE. In the meantime we are not waiting. We are going ahead with the Commission's approved program. If you say the program is reduced, I think this would be correct in terms of the Interdepartmental Committee's recommendation. Insofar as the AEC is concerned, it is this much added effort to the program. It does not constitute a reduction.

Representative VAN ZANDT. Then for fiscal 1961, the program would really be under supervision of the AEC.

Mr. LUEDECKE. This low level treatment program would be. The only thing we would have to do on the high level program is that we will go ahead with the construction of a facility the Army decides that it wants. We would not propose to take over management of the high level irradiation program under these recommendations.

Representative HOLIFIELD. The committee or most of the members are disappointed in the way this matter has been handled. There will be a letter addressed to you on this, Mr. McCone, as of today. We hope that we can take this matter up a little bit further in April. It seems to some of us that Mr. Morse was appointed to evaluate this program, apparently, and he moved rather fast without consultation with the various departments. You might say he blocked this program from the tempo at which it was proceeding before he came into the picture. I don't know whether the fact that Mr. Morse comes from the frozen food industry has anything to do with this decision or not. I would hate to think so. But it is a fact that he comes from a sector of food processing which is competitive to this irradiation processing. I am making no accusation, of course, but it is interesting to note that the minute he came into the program the program got sabotaged or blocked or minimized to the point where another one of our so-called atoms for peace programs now begins to hit this dragout, this lagtime or leadtime, about four times as slow as it was originally planned.

I think we probably would want to take this up a little further in April. Mr. Price has a research and development subcommittee which may want to hold a hearing on this.

(The following correspondence occurred between the Joint Committee and the Commission:)

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D.C., March 7, 1960.

HON. JOHN A. MCCONE,
Chairman, U.S. Atomic Energy Commission.
Washington, D.C.

DEAR MR. MCCONE: On January 14, 1960, the Joint Committee held public hearings on the decision by the Department of the Army to cut back on its food irradiation research program. During the hearings, we discussed the report of the Ad Hoc Panel of the Interdepartmental Committee on Radiation Preservation of Food which report, in draft form at that time, contained recommendations for the formulation of a national civilian program with the Atomic Energy Commission designated as the operating agency.

The final Ad Hoc Panel report has been received by the Interdepartmental Committee and submitted to the interested agencies, including the Department

of the Army and the Commission. I would hope that appropriate action can now be taken without further delay to carry out the recommendations of the report and that the Commission would be prepared to proceed immediately to carry forward a vigorous program.

As you know, the Joint Committee was quite disappointed and somewhat disturbed by the manner in which the Department of the Army in October 1959 suddenly announced its decision not to proceed with the Ionizing Radiation Center. Previously in 1955 and 1956, representatives of the Commission and the Department of the Army had testified favorably as to the economics and objectives of the program and had informed the Committee that construction of the Center would commence in 1957 and that it would be in operation in 1958.

Thereafter the Joint Committee was not properly kept "currently and fully informed" as to the program, particularly as it failed to proceed as scheduled and along the lines the committee had been led to expect. The hearing on January 14, 1960, for example, brought out that construction of the Center never even commenced. It was ascertained that decisions were made by the Department of the Army without proper interagency coordination and that the decision to cancel construction came as a surprise to the AEC as well as the Joint Committee.

The joint committee hearing on January 14, 1960, also developed the fact that no adequate scientific data supported the Army's determination to cut back on the program. A report by the A. D. Little Co. which was "used partially as a basis" for the Army decision to cancel was not even read by the technical director of the project. The Army, in a letter to a Member of Congress a few days before deciding to cancel the project, went so far as to say that "progress has been substantial and encouraging and the program is now ready for the pilot plant testing phase."

Whether or not the Army was justified in its decision either from a scientific or economic point of view, I believe it is of the utmost importance that the United States move ahead with a definite food irradiation program. I believe the Government should proceed to establish a food irradiation center and that necessary attention should be given immediately to this matter in order that authorization and appropriation legislation could be considered during this session of the Congress. Since the Department of the Army for one or more reasons decided not to follow through with the original objectives, I believe the Commission is the proper agency to support this program in cooperation with private citizens and companies interested. The joint committee would endorse the assignment of the food irradiation program to the AEC and would be prepared to support a vigorous program to further the development of this concept of the peaceful atom.

The failure of our Government to adequately support the food irradiation program, I believe, is merely symptomatic of our entire atoms-for-peace program. The many glowing promises which were made to the world during the period 1953–56 have not been fulfilled. It may still not be too late. We cannot, however, afford to waste any more time nor to make promises to our free world friends that are not being supported by our action. The Commission today, I believe, should be in a position to go ahead with the program and endeavor to put it back into operation and further its advancement.

I have discussed the above with my colleagues on the joint committee, Congressmen Carl T. Durham, Chet Holifield, Mel Price, and James Van Zandt, and they advise me that they concur in my views.

I am sending a copy of this letter to the Secretary of the Army.

Sincerely yours,

CLINTON P. ANDERSON, *Chairman.*

ATOMIC ENERGY COMMISSION,
Washington, D.C., March 24, 1960.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: Just prior to receipt of your letter of March 7, 1960, concerning the food irradiation research program, the Commission forwarded to the Joint Committee the outline of the radiation processed foods program which the Commission had just approved. Although the Commission's radiation processed foods program is not identical with the program recommended by the Interdepartmental Committee on Radiation Preservation of

Foods, it is consistent with the latter program in both size and scope. Adjustments have been made to recognize the passage of time and to increase the emphasis on fundamental studies, such as wholesomeness. We will be happy to explain the new program in greater detail at the hearings of the Subcommittee on Research and Development on March 31, 1960.

Your letter comments at length on the decision of the Department of the Army not to proceed with the ionizing radiation center at Stockton, Calif. As explained at the hearing on January 14, the proposed ionizing radiation center was a Department of the Army funded project. The Commission participated in the project only to the extent of awarding and administering a contract, with Army funds, for the design and construction of a cobalt-60 irradiation facility for the center.

Since your letter of March 7, the Army has reached some decisions concerning the future of its high-dose radiation processed foods program and its plans for a food irradiation research and development center. The revised Army plans have now been given to the staff of the Joint Committee. It is apparent, from these plans, that the Army's program on high-dose radiation processing of foods will constitute a program which is complementary to the newly established Commission low-dose radiation processed foods program. The Commission has been informed by the Department of the Army that the latter's proposed research and development facility will be made available for use in the Commission's radiation processed foods program.

As stated in our letter of March 9, 1960, the Commission's radiation processed foods program does not currently envision the need for constructing a food irradiation center. During the initial 6 to 8 months of the Commission's program, studies that will be conducted should indicate more clearly the nature of the irradiation facilities needed for the Commission's program. At present, it appears that small irradiation facilities, located in several areas of the country near food sources, may be more useful in the Commission's program than would one research center.

The Commission's radiation processed foods program will concentrate on low-dose processing of food. Both the Commission and the Interdepartmental Committee believe low-dose processing to be of greatest interest to the civilian economy. Since the Army has now decided to proceed with its own high-dose radiation processing program, the Commission does not believe that it should be given overall responsibility for a national food program that would include both high- and low-dose processing. The Commission and the Army have taken steps to establish strong liaison between the two agencies in the radiation processed foods programs.

The Commission believes that the radiation processed foods program of the Commission, together with the Army's program, will constitute the basic elements of an aggressive national program. We anticipate that other governmental agencies will wish to augment the program and participate actively therein. We feel that the result will be an aggressive national radiation processed foods program of great value of both national and international interests.

Sincerely yours,

JOHN MCCONE, *Chairman.*

Representative PRICE. I would suggest to the committee on authorization that they defer final action on their authorization bill pending a hearing by our research and development committee on the subject of food irradiation.

Representative HOLIFIELD. I think that would be in order.

Mr. MCCONE. Perhaps Dr. Dunham may have a remark to make. He has been following this from a biological and medical standpoint.

Dr. DUNHAM. Yes. I think it is important to keep in mind in terms of how fast you go ahead with what is a new program, this low-level irradiation, that one has to be assured that this food is really going to be accepted by the Food and Drug Administration and other bodies, such as the Department of Agriculture, which are concerned with these matters. I personally think that the foods will meet these requirements but I also think that this is the thing to get done first. This is what Dr. Aebersold and I are planning in this new program: To select foods which have good marketability from the

standpoint of an added week or two of shelf life making a great deal of difference, find out whether the irradiation affects their flavor at all over that period of time, and then go into careful testing. I was very pleased with the results of the military testing program. They ran into a few snags in terms of possible deleterious substances in the foods.

Representative PRICE. Doctor, didn't we cover that pretty thoroughly in the hearing that we had in January? There was considerable conflicting testimony on that.

Dr. DUNHAM. That is correct.

Representative PRICE. Even going back to witnesses who had been used to develop this point, who then testified in a contrary fashion.

Dr. DUNHAM. I think all I was trying to say is that it looks good to me.

Representative PRICE. I am not worrying very much here about excessive speed on any of these programs.

Representative HOLIFIELD. I think that is the most cogent remark of the afternoon. I think we were on Project 61–d–9, General Luedecke.

REACTOR DEVELOPMENT PROGRAM

Mr. LUEDECKE. Project 61–d–9, advanced test reactor, as indicated in the chairman's statement, provides for the construction of a new 250-megawatt high fast flux test reactor, to provide the necessary amount and kind of test space required for the Navy and the fuel cycle development requirement that cannot be provided with existing Commission test reactors.

Mr. HOLIFIELD. This is a $24 million item.

Mr. LUEDECKE. That is correct.

Representative HOLIFIELD. This is not the high flux reactor that we were talking about before.

Mr. LUEDECKE. It is a high flux test reactor.

Representative HOLIFIELD. It is?

Mr. LUEDECKE. Yes, sir.

Representative HOLIFIELD. Has the location been selected for this?

Mr. LUEDECKE. No, sir. The Commission has not decided where it would go.

Representative HOLIFIELD. Wasn't there an item of $27.5 million in the 1960 fiscal year operating funds which had something to do with this same matter?

Mr. LUEDECKE. I am not sure of the amount, but it was approximately that. It had to do with the requirements for irradiation testing. This provides the funds which will be used, for example, to construct the B. & W. reactor, as now proposed in the intermediate flux range.

Representative HOLIFIELD. It would not be this reactor?

Mr. LUEDECKE. No, sir.

Representative HOLIFIELD. Was there a proposal from the Republic Aviation group on this same reactor or not?

Mr. LUEDECKE. No, sir. The proposal from the Republic Aviation group was in response to invitations that were issued in which we accepted one in the intermediate range, the Babcock & Wilcox reactor. We have not solicited proposals for this reactor.

Representative HOLIFIELD. You have not gotten to the point where you can tell us what your schedule is on this for invitation of bids or design.

Dr. PITTMAN. Sir, could I go back to one point. When we went out with invitations previously we did have some high flux requirements in the invitation. Republic Aviation, you asked about that particular proposal, did in submitting their proposal indicate that they could furnish a portion of that high flux requirement that we at that time had identified. They could not furnish it all and none of the proposals could furnish it all. So when we accepted the B. & W. proposal this did not meet our high flux requirements. Since that time we have more clearly identified the high flux requirements. We have more clearly defined them in our judgment. This reactor is to meet specifically those requirements. With regard to schedule, sir, we have not yet been able to determine what schedule of construction we would have. We would not propose to go out with invitations on this one but rather to build it ourselves.

Representative HOLIFIELD. But you want the money in this year's budget?

Dr. PITTMAN. Yes, sir.

Representative HOLIFIELD. So it would indicate that you are planning on going ahead with it before the end of the year.

Dr. PITTMAN. The situation on this, sir, is that we are doing a conceptual design study now with the Phillips Co. and other contractors working together, working with the Navy so that their requirements fit into this design. As soon as we have a conceptual design, we would be in a position to make decisions to go out for construction contracts and where to locate the reactor. We expect to start the construction within this calendar year.

Representative HOLIFIELD. Will you proceed, General.

Mr. LUEDECKE. Project 61–e–1, additions and modifications to the MTR–ETR area, National Reactor Testing Station, Idaho, $800,000. This project will provide for the construction of a building necessary to provide space for engineers and technical personnel associated with the irradiation experiments in the MTR and ETR.

The construction of this building would overcome inefficient and overcrowded situations currently existing at the test site in connection with the test reactor. It will provide working space for about 200 engineers, draftsmen, and sponsor representatives presently housed in several remote and severely crowded facilities. It will also make available a classified storage vault which will stock classified documents for the technical library which are now housed in a storage vault for reactor fuel elements and classified experimental subassemblies.

Representative HOLIFIELD. You had last year almost the same thing, it looks like to me, in project 60–e–3, alteration, modifications, and additions to MTR–ETR technical and support installations, National Reactor Testing Station, Idaho, $2 million.

Is this related to that?

Dr. PITTMAN. This is in addition to what we have done last year. This is required now because more and more loops are going into the ETR. There are crowded conditions with the engineers working on those loops, and this does not lead to any kind of decent efficiency.

Representative HOLIFIELD. I note this runs about $26 a square foot. Is that the customary cost of construction in that area?

Dr. PITTMAN. I would rather ask somebody from the construction end to answer it, but I believe that is consistent with the construction in that area. Twenty-five or twenty-six dollars a square foot is not out of line at all.

Mr. LUEDECKE. The building, I am informed, is $18.50 per square foot.

Representative HOLIFIELD. Is there an additional amount for equipment?

Dr. PITTMAN. The building itself is estimated at 31,000 square feet at $18.50 per square foot. The equipment, overall cost, design and contingencies constitute the remainder of the $800,000.

Representative HOLIFIELD. That does include some equipment.

Dr. PITTMAN. Yes, sir; it does.

Representative HOLIFIELD. The backup doesn't show that. There is no mention of the equipment in the item that we have here.

Dr. PITTMAN. I will provide that for record.

(The information referred to follows:)

Project 61–e–1. Additions and modifications, MTR–ETR Area, NRTS, Idaho

Details of cost estimate:	
Engineering design and inspection	$95,000
Construction cost	[1] 600,000
Contingency	105,000
Total	800,000

[1] Included in this estimate is $6,000 for the purchase of office furniture.

Dr. PITTMAN. Project 61–e–2, site utilities, Brookhaven National Laboratory, $1,250,000. This provides for the enlarging and improving of the heating and electrical utility systems for the laboratory. These improvements are required to provide for the expanding needs of the laboratory due to the construction of new facilities and the need to improve existing installations to provide reliability and a more economical system.

The immediate specific need is concerned with the utilities for projects presently underway or recently completed. As an example, the alternating gradient synchrotron, or for authorized buildings or projects which will be either in active design stage or under construction in the coming year, such as the research reactor, physics building, nuclear engineering building. The work will consist first of increasing the capacity of steamlines by extension of the underground distribution main, increasing a main transformer substation and extending the underground electrical duct bank system.

Representative HOLIFIELD. Ordinarily the utilities are included in the cost of a building. But apparently this is an expansion of an existing utility system.

Mr. LUEDECKE. Yes.

Representative HOLIFIELD. That is why it is a separate item?

Mr. LUEDECKE. The entire system utility; yes, sir.

Representative HOLIFIELD. Let us go to the next item.

Mr. LUEDECKE. Project 61–e–3, quarters for visting scientists, Brookhaven National Laboratory, $550,000. This project provides for construction of 56 housing units to provide living accommodations for short-term visiting scientists and the on-call staff of the laboratory.

The remote physical location of the laboratory requires that temporary apartment units, principally 1-bedroom units, be constructed adjacent to the Laboratory to overcome an inefficient and unsatisfactory housing arrangements for visiting scientists and the on-call staff required to properly staff the installation.

At present there are 70 temporary apartments on the site. The forecast for 1962 provides for a total of 190 research associates, visiting staff, and on-call staff. While the addition of the 56 housing units will not fully accommodate this number it will meet the most urgent requirements on a conservative basis. This program of visiting scientists is extremely valuable from several viewpoints. It gives the Laboratory the services of a large number of experienced scientists whose presence not only augments the work accomplished but also contributes intangible benefits from the exchange of ideas. The experience and training acquired by the younger visitors greatly strengthens the total national scientific program through the increased effectiveness of the visitors when they return to their home installations.

Furthermore, in many instances universities are able to attract and keep distinguished scientists because of the research opportunities afforded at Brookhaven. This is a facility which has been requested by the Laboratory for a great number of years and has never been granted.

Representative HOLIFIELD. General Luedecke, this will take care of about 56 units apparently and 64 rooms. If we have done our arithmetic right, it runs about $8,600 per room. The engineering design has a figure of 11½ and 12 percent for contingency. In the construction of this kind of building, do you need 23½ percent for engineering design inspection and contingency?

It runs up pretty high, $8,600 per room.

Mr. DERRY. Mr. Holifield, the estimates that we have for the building are $16 a square foot. The overall cost of 16,200 square feet in these 56 units is about $34 a square foot. This is a completely built quarters for the scientists. These quarters we are talking about here are similar to the quarters that are built at Argonne National Laboratory now, the motel type. We feel that the $16 a square foot is comparable to building costs.

Representative HOLIFIELD. You are applying that to the halls and everything else?

Mr. DERRY. This is for everything.

Representative HOLIFIELD. $16 a square foot?

Mr. DERRY. About $16 a square foot.

Mr. RAMEY. You mean you can build living facilities for $16 a square foot?

Mr. DERRY. The overall cost for a completely constructed and furnished facility is about $34 a square foot.

Mr. RAMEY. That is the actual. For $16 a square foot nowadays you can hardly build warehouse space.

Mr. DERRY. Yes. We can build warehouses for $5 a square foot.

Mr. RAMEY. I have seen a few warehouses that might cost more than that.

Representative HOLIFIELD. What about this 11½ and 12 percent? It looks like you boys are putting in plenty of cushion there.

Mr. DERRY. The 11½ percent of construction costs is for engineering design and inspection. This is the general figure we usually use for almost any conventional type project, 9 to 12 percent on engineering cost. The contingency is 12 percent of other costs. It is simply a figure that we always put in on our project proposals because the thing is not designed yet, and we don't have it well enough scoped. We don't expect to use that 12½-percent contingency if we do not have to use it for the scope of the project we have proposed.

This is an ordinary way of presenting estimates. This is the normal way of presenting figures before we have the project designed.

Representative HOLIFIELD. I wish you well with the Appropriations Committee on that item.

Mr. RAMEY. Is providing this type of facility likely to generate requests for similar type facilities at other installations? You mentioned this is the kind of building they have at Argonne. Don't they have considerably fewer units? Won't Argonne decide they need more of them and Los Alamos and so on?

(The AEC subsequently informed the committee that there are 86 rooms available for visitors at Argonne National Laboratory.)

Mr. LUEDECKE. Argonne, of course, already has this particular facility and it is being used for this purpose and in some cases for foreign students.

Representative HOLIFIELD. Do you rent these, or are they furnished free to these visiting scientists?

Mr. LUEDECKE. They are rented to them.

Representative HOLIFIELD. Fifty cents a night.

Mr. BURROWS. You pay in effect the prevailing rate. I am not sure the exact number. We can put it in the record. It is something around $4 or $5 a night.

(The AEC subsequently informed the committee that three types of quarters are available and rent for $2, $4, and $5 per day.)

Representative HOLIFIELD. I thought it might be a courtesy arrangement as they make for a Congressman when he visits an Army barracks and he is allowed to pay 50 cents a night to sleep on the Army cot.

Mr. LUEDECKE. In response to the question whether this might generate further requests for like facilities, I am not aware of any at this time. On the other hand, we have locations that are relatively as remote in terms of accommodations as this one, and it is quite possible, although I have none in hand at the moment.

Mr. RAMEY. Do you intend to maintain your existing facilities that you use for scientists at Brookhaven still?

Mr. LUEDECKE. Perhaps. As you know, these are a series of old World War II barracks. They are being maintained for this as well as other purposes. This is getting very fine. We would hope not to have to continue to maintain them any longer than essential.

Representative HOLIFIELD. Let us go to the next item.

PHYSICAL RESEARCH PROGRAM

Mr. LUEDECKE. Project 61–f–1, bubble chamber house, Brookhaven National Laboratory, $1,660,000. This project provides for construc-

tion of a building to house the 80-inch bubble chamber for use in connection with the alternating gradient synchrotron. The project also provides for construction of a tunnel section necessary to bring elementary particle beams from the accelerator to the bubble chamber. An exterior yard area is required for beam-guiding equipment. High density concrete shielding is included for the bubble chamber.

The bubble chamber house is required because the bubble chamber and auxiliary equipment are too large to get inside the existing target building.

The large size of the chamber is dictated by the high energies made possible by the alternating gradient synchrotron.

Representative HOLIFIELD. The next item.

Mr. LUEDECKE. Project 61–f–2, Princeton-Pennsylvania accelerator addition, $1,350,000. This project provides for the construction of an addition to the present office and laboratory building and also for construction of a new storage building. The present office and laboratory building is immediately adjacent to the accelerator proper. Hence it is a logical and ideal place to house the scientific staff and their experimental equipment. Since this building is currently 100 percent occupied by accelerator engineering and administrative staff, a new wing is needed to relocate the engineering and administrative staff thereby making room for experimental and theoretical scientists who will be using the machine.

The storage building will have an area of 20,000 [1] square feet, and it is estimated to cost $110,000. This building is required to store bulk materials and auxiliary equipment temporarily not in use.

Representative HOLIFIELD. What is the total cost of this accelerator?

Dr. MCDANIEL. About $11 million.

Representative HOLIFIELD. What is the annual operating cost?

Dr. MCDANIEL. We as yet have not had any experience with it, but we estimate that when it is constructed and available for us that it will cost about $3 million annually.

Representative HOLIFIELD. What does this give us different from the Harvard-MIT and other accelerators? Is it another accelerator along the same line?

Dr. MCDANIEL. The Harvard-MIT accelerator is a 6-billion-volt electron accelerator and will allow us to study the effect of high energy electrons on nuclear matter. The Princeton-Pennsylvania accelerator is a 3-million-volt high intensity proton accelerator which will allow us to study the effects of 3-billion-volt protons on nuclear matter.

Mr. LUEDECKE. Project 61–f–3, accelerator and reactor additions and modifications at Brookhaven National Laboratory, $1,280,000. This will provide for alterations and modifications and additions to major research machines at Brookhaven National Laboratory, including the graphite research sector, the cosmotron, and the alternating gradient synchrotron. The work which may be undertaken are the following items.

With respect to the graphite research reactor, the removal and disposal of exhaust duct air filters, purchase and installation of new filters.

With respect to the cosmotron—(1) providing new direct current power supplies, 125- and 250-kilovolt motor generating sets, and (2) four new straight magnet sections.

[1] AEC subsequently informed the Joint Committee that this figure should be 10,000 square feet.

With respect to the alternating gradient synchrotron—beam separators, power distribution, and switchgear for experimental equipment, hydrogen safety devices, fixed steel and concrete shielding, and experimental power supplies.

61–f–4, $12 million, high flux isotope reactor, Oak Ridge National Laboratory, Tenn.: This project provides for the construction of a high flux reactor operating at a design power of 100 megawatts, with a maximum flux in the region of 3 to 5×10^{15} neutrons per square centimeter per second, for the production of transuranium elements and special isotopes of lighter elements.

The reactor will be a water-cooled type, using a flux-trap core geometry. This reactor is needed to produce sufficient quantities and requisite purities of transuranium elements required to initiate and conduct a long-range heavy element research program. The rate of production of isotopes formed by multiple neutron capture increases rapidly as neutron flux increases.

For example, it takes about 10 years to convert .05 percent of curium 244 to californum 252 at a flux of 4.5×10^{14}, but only 8 months to convert the same amount at a flux of 5×10^{15}. Accordingly high neutron fluxes are essential to research in the heavy element region.

In addition, an increased neutron source strength would make possible more refined studies of nuclear structure and properties. Other fields of research which would profit from higher fluxes include measurement of neutron cross sections, neutron diffraction techniques and the study of structure and properties of solids, liquids and gases, fission studies, and radiation chemistry. The decision to locate the reactor at Oak Ridge is based on, first, availability of facilities for processing and distributing the products of radiation, second, availability of fuel processing facilities, and third, recognition that ORNL is a national center for isotope research and development.

Representative HOLIFIELD. Is this a realistic estimate, this $12 million, or are we going to be faced with an increase when we get to work on this and run it up three times?

Dr. MCDANIEL. We believe it is realistic. We have no evidence that it will overrun at this stage of the game. We believe it is a realistic estimate.

Representative HOLIFIELD. Have you ever built this kind of reactor before?

Dr. MCDANIEL. Reactors have been built by Oak Ridge of the same general type but not one of this high flux.

Representative HOLIFIELD. So you do have some experience in building to go by.

Dr. MCDANIEL. This is one of the reasons that the Oak Ridge National Laboratory has been selected as the location for it, yes.

Mr. RAMEY. When was the last one built?

Dr. MCDANIEL. The Oak Ridge research reactor has just been completed recently.

Mr. RAMEY. What is your flux on that one compared to this one?

Dr. MCDANIEL. A factor of 10 lower.

Representative HOLIFIELD. What will the operating cost be of this new reactor?

Dr. MCDANIEL. Again it is a little difficult to say what the actual operating cost will be but we have made some estimates. The reactor operation itself is estimated to cost about three-quarters of a million

dollars per year. But in addition it will be necessary to do fuel element fabrication which adds another $500,000. Fuel reprocessing cost may be in the neighborhood of $1½ million a year. Therefore it is safe to assume that the operating cost will be at least $2 million a year.

Representative HOLIFIELD. This is basic research mostly?

Dr. MCDANIEL. The materials produced in this reactor will be of invaluable use in basic research; yes.

Mr. RAMEY. Will you sell them or market them or distribute them through your isotope program?

Dr. MCDANIEL. The amount that will be produced of the transuranic elements are so small and the skill for studying the isotopes or doing the research with them lies within some of our Commission laboratories. It is not likely that the material will be made available to the public.

Representative HOLIFIELD. I mean to other universities.

Dr. MCDANIEL. If a special skill exists in one of the universities in a research program which can make use of these materials we would make it available.

Mr. LUEDECKE. We would use this machinery for distribution. It is unlikely that anyone will want to buy it.

Representative HOLIFIELD. Let us take the next item.

Mr. LUEDECKE. Project 61–f–5, accelerator improvements, Lawrence Radiation Laboratory, California, $950,000. This project provides for the alterations and modification and additions to the major research machine at Lawrence Radiation Laboratory which includes the bevatron, 184-inch cyclotron and heavy ion accelerator. The purpose of the project is to increase the usefulness and operating efficiency of these research machines. Illustrative examples of the work that may be undertaken follow: With respect to the bevatron increased cooling capacity, direct current power supplies, and procurement of additional shielding and magnets. With respect to the 184-inch cyclotron magnetic amplifier rectifiers, and generator for analyzing magnets. With respect to the heavy ion accelerator installation of strong focusing in the prestripper accelerator of the Hilac.

Representative HOLIFIELD. How have these reactors been working lately? Have they been operating in very good shape?

Dr. MCDANIEL. Very good.

Representative HOLIFIELD. I mean accelerators. Has there been any interesting accomplishment recently?

Dr. MCDANIEL. Some of the studies on the heavy ion accelerator have shed a great deal of light on the new heavy elements, element 102 and perhaps 103. So the answer to your question is, "Yes", a great many discoveries have come out of this accelerator.

Representative HOLIFIELD. You are utilizing this to full capacity?

Dr. MCDANIEL. That is correct. Almost on a 24-hour-a-day basis.

Representative HOLIFIELD. The additional costs include additional areas of use?

Dr. MCDANIEL. Yes.

Representative HOLIFIELD. Will you proceed to the next one?

Mr. LUEDECKE. Project 61–f–6, bevatron shielding, Lawrence Radiation Laboratory, $1.1 million. This project consists of the design, fabrication, and erection of additional bevatron shielding required to provide adequate protection from radiation levels.

At present the maximum beam intensity of 2 x 10^{11} protons per pulse sustained at 10 pulses per minute produces a maximum radiation level permissible for personnel. Since the level is above this in some parts of the building this limitation interferes with operations and work schedule around the bevatron. At existing beam levels the need for additional shielding is essential. With the proposal to increase the beam intensity by two orders of magnitude to 10^{13} protons per pulse the requirement for greatly increased shielding is critical. The work will consist of floor alterations, foundations, shielding, roof supports in the injector and wind tunnel area and roof alterations necessary to accommodate the heavy loads of the planned shielding. Long-range plans call for further increasing the bevatron beam intensity to 10^{13} protons per pulse and provision will be made under this project for foundation and support structure work capable of accepting further necessary shielding at this later date.

Representative HOLIFIELD. Let us take the next two, the physical research items, and then we will adjourn for the day and get to the other items on Thursday.

Mr. LUEDECKE. Project 61–g–1, metallurgy building extension, Brookhaven National Laboratory, $655,000. This project consists of two parts. Modification of the existing metallurgy building, building 480, and construction of an addition to the same building. Modifications to the existing building will consist largely of partition work and the rearranging of utilities, water, gas, and power.

The extension will be a two-story structure having a gross area of 12,200 square feet. The addition and modifications are required to relieve the severe overcrowding of existing facilities and to provide facilities not now included.

Project 61–g–2, addition to the cyclotron building, Lawrence Radiation Laboratory, $500,000. This project provides for the addition of 9,000 gross square feet to the experimental area of the 184-inch cyclotron. This additional space is required because the present experimental area is very limited.

At the time of the conversion of the cyclotron to its present energy level, 730 Mev. for protons, the size of the proton cave in the present experimental area was increased to the maximum possible. In addition, a small cave for medical work and a meson cave for work with internally produced meson beams were also provided. All of these facilities were of the maximum size permitted by the limitations of the building and the requisite shielding. The increased cave facilities associated with the cyclotron conversion have eliminated the floor space that was available outside of the caves. Most of the present building space is occupied by shielding and caves and the experimental equipment takes up most of the balance of the limited area available. Consequently the congested conditions for day to day operations have become inherently hazardous.

The proposed 32-foot extension of building six surrounding approximately one-third of the building will provide space to perform properly, efficiently, and with greater safety the experimental functions which are now limited by the size of the building.

Representative HOLIFIELD. This will be in effect making the major cyclotron much more useful in an area that you cannot handle at the present time?

Mr. LUEDECKE. That is correct.

Representative HOLIFIELD. All right; I think we will close the meeting at this point and take the other matter up on Thursday. We have an executive session tomorrow morning at 10 o'clock. Thank you, gentlemen, for your testimony.

(A comparison of AEC division requests for construction projects, with estimates as submitted to the Bureau of the Budget, follows:)

Plant acquisition and construction

[In millions]

Program	Division request		Submission to Bureau of the Budget		Change	
	Authorized	Funding	Authorized	Funding	Authorized	Funding
PHYSICAL RESEARCH PROGRAM						
1. Princeton-Penn accelerator, Princeton University	$10.8	$10.8	$1.4	$1.4	−$9.4	−$9.4
2. Major bevatron improvements, Lawrence Radiation Laboratory	11.2	4.2	1.1	1.1	−10.1	−3.1
3. High energy physics research facility, Argonne National Laboratory	6.8	1.6	0	0	−6.8	−1.6
4. Radiation laboratory, Notre Dame University	2.2	2.2	0	0	−2.2	−2.2
5. Elementary Particle Physics Laboratory, University of Chicago	.6	.6	0	0	−.6	−.6
6. Inorganic Materials Laboratory, Lawrence Radiation Laboratory	2.5	2.5	0	0	−2.5	−2.5
7. Materials Research Laboratory, University of Illinois	5.6	5.6	0	0	−5.6	−5.6
8. General plant projects	5.7	5.7	3.5	3.5	−2.2	−2.2
9. Chemistry Laboratory, Brookhaven National Laboratory	6.4	6.4	0	0	−6.4	−6.4
10. 4th floor, addition to Solid State Laboratory, Oak Ridge National Laboratory	.2	.2	0	0	−.2	−.2
11. Equipment decontamination building, Oak Ridge National Laboratory	.4	.4	0	0	−.4	−.4
12. Mechanical shops building, Lawrence Radiation Laboratory	2.6	2.6	0	0	−2.6	−2.6
13. Applied research building, Lawrence Research Laboratory	3.3	2.4	0	0	−3.3	−2.4
14. Sherwood office building, LASL	.2	.2	0	0	−.2	−.2
Projects unchanged	32.0	17.0	32.0	17.0	0	0
Grand total, physical research	90.5	62.4	38.0	23.0	−52.5	−39.4
Reactor development:						
1. Addition and modification, MTR–ETR	2.7	2.7	.8	.8	−1.9	−1.9
2. General plant projects	10.8	10.8	9.0	9.0	−1.8	−1.8
3. Heating plant boiler, ANL	2.5	2.5	0	0	−2.5	−2.5
4. Reactor engineering building, ANL	3.0	3.0	0	0	−3.0	−3.0
5. Administration and service building, ANL, A–E	.4	.4	0	0	−.4	−.4
6. Shielding facility, high level alpha, ANL, A–E	.6	.6	0	0	−.6	−.6
7. Health and safety building, NRTS	1.2	1.2	0	0	−1.2	−1.2
8. Machine shop, NRTS	.7	.7	0	0	−.7	−.7
9. CPP area, modification, NRTS	1.7	1.7	0	0	−1.7	−1.7
10. CPP test building	1.8	1.8	0	0	−1.8	−1.8
11. CPP head-end dissolution	3.3	3.3	0	0	−3.3	−3.3
12. Permanent road, NRTS	.8	.8	0	0	−.8	−.8
13. Sodium compound, test facility	3.2	3.2	0	0	−3.2	−3.2
14. High level analytical laboratory	1.9	1.9	0	0	−1.9	−1.9
15. Addition to high level chemonuclear development	.6	.6	0	0	−.6	−.6
16. Maritime gas-cooled reactor	13.0	13.0	0	0	−13.0	−13.0
17. Reactor modification to Naval Prototype Plant	5.6	5.6	0	0	−5.6	−5.6
18. Reactor support installation, NTS	.4	.4	0	0	−.4	−.4
Projects unchanged	184.8	183.0	184.8	183.0	0	0
Grand total, reactor development	239.0	237.2	194.6	192.9	−44.4	−44.4

Plant acquisition and construction—Continued

[In millions]

Program	Division request		Submission to Bureau of the Budget		Change	
	Authorized	Funding	Authorized	Funding	Authorized	Funding
BIOLOGY AND MEDICINE PROGRAM						
1. Installations for support of biomedical research projects in atomic energy	$8.0	$8.0	$4.0	$4.0	−$4.0	−$4.0
2. General plant projects	.4	.4	.3	.3	−.1	−.1
Total biology and medicine	8.4	8.4	4.3	4.3	−4.1	−4.1
CIVILIAN APPLICATION OF ISOTOPES AND NUCLEAR EXPLOSIVES						
1. Hot laboratory for isotope separations	1.3	1.3	0	0	−1.3	−1.3
2. Chemonuclear reactor, A-E	1.0	1.0	0	0	−1.0	−1.0
Total civilian application of isotope and nuclear explosives	2.3	2.3	0	0	−2.3	−2.3
SPECIAL NUCLEAR MATERIALS						
1. Modifications to production and supporting installations	14.0	14.0	12.0	12.0	−2.0	−2.0
2. Physical constants test reactor	.9	.9	0	0	−.9	−.9
3. Fire protection improvements, Oak Ridge	2.5	2.5	0	0	−2.5	−2.5
4. Reactor fuel measurement facility, Waltz Mill, Pa.	.2	.2	0	0	−.2	−.2
5. All other	22.6	47.6	22.6	47.6	0	0
Total special nuclear materials	40.2	65.2	34.6	59.6	−5.6	−5.6
WEAPONS						
1. General plant projects	9.0	9.0	8.5	8.5	−.5	−.5
2. All other	19.0	19.0	19.0	19.0	0	0
Total weapons program	28.0	28.0	27.5	27.5	−.5	−.5

(Whereupon, at 4:40 p.m. Tuesday, March 8, 1960, the hearing was recessed, to reconvene at 10 a.m., Wednesday, March 9, 1960, in executive session and to meet in open session at 10 a.m., Thursday, March 10, 1960.)

AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1961

THURSDAY, MARCH 10, 1960

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON LEGISLATION,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D.C.

The subcommittee met, pursuant, to notice, at 10 a.m., in room F–39, the Capitol, Hon. Chet Holifield (chairman of the subcommittee) presiding.

Present: Senators Anderson, Gore, Dworshak, and Aiken; Representatives Holifield, Van Zandt, Hosmer, Bates, and Westland.

Also present: James T. Ramey, executive director; John T. Conway, assistant director; David R. Toll, staff counsel, George F. Murphy, Jr., professional staff member; Edward J. Bauser, technical adviser; and Bernard V. Dvoskin, GAO consultant.

Representative HOLIFIELD. The subcommittee will be in order.

BIOLOGY AND MEDICINE PROGRAM

We will start on page 5 of the bill, project 61–h–1, installations for support of biomedical research in atomic energy, $4 million.

STATEMENTS OF JOHN A. McCONE, CHAIRMAN, GEN. A. R. LUEDECKE, GENERAL MANAGER; DR. CHARLES L. DUNHAM, DIRECTOR, DIVISION OF BIOLOGY AND MEDICINE; BRIG. GEN. A. D. STARBIRD, DIRECTOR, DIVISION OF MILITARY APPLICATION; DR. FRANK K. PITTMAN, DIRECTOR, DIVISION OF REACTOR DEVELOPMENT; REAR ADM. HYMAN G. RICKOVER, U.S. NAVY, ASSISTANT DIRECTOR FOR NAVAL REACTORS, DIVISION OF REACTOR DEVELOPMENT; DON S. BURROWS, CONTROLLER, DIVISION OF FINANCE; FRANCIS J. McCARTHY, ASSISTANT CONTROLLER FOR BUDGETS, DIVISION OF FINANCE; AND PAUL W. McDANIEL, ACTING DIRECTOR, DIVISION OF RESEARCH, ATOMIC ENERGY COMMISSION

Mr. LUEDECKE. I would like to correct an error in our testimony on Tuesday, Mr. Chairman, when it was indicated that the size of this project was the same as for last year. This was in error. In fact, last year's project was $3 million and this is $4 million.

Representative HOLIFIELD. I noted that 2 years ago you had $2 million, last year $3 million, and this year $4 million. I appreciate the increases involved in this. I am wondering if the increase is in line

with the program which is needed in this field in view of the hearings we have held.

Is there any part of your program that has gone down in need, that is, decreased in need? That is, in the field of biology and medicine? As I understand it, in this field you are doing all the animal work, all the measurements of radiation, effects on animal tissue, and all of that.

Dr. DUNHAM. No; that need has not gone down. This figure of $4 million is exclusively for construction in relation to that type of work.

Representative HOLIFIELD. What facilities are involved in this $4 million?

Mr. LUEDECKE. Involved in this is a fast-burst reactor at Oak Ridge National Laboratory, $1,410,000; radiobiological laboratory and animal quarters for studies of effects of chronic radiation, $1 million; laboratory and animal facilities for inhalation studies, $1 million; and additions and modifications of a similar nature to those in 1960, for $590,000, making a total of $4 million.

I have here, sir, a list of the facilities for which the $3 million has been obligated in 1960, if you would like it for the record.

Representative HOLIFIELD. All right. You asked for $2 million and we gave you $3 million?

Mr. LUEDECKE. Yes.

Representative HOLIFIELD. You have committed that $3 million?

Mr. LUEDECKE. Yes, sir; we have committed it for swine radiation genetics laboratory, Iowa State College, $317,000; dog-holding facilities, Davis Dog Project, University of California, $350,000; addition to animal quarters biology building, Argonne, $450,000; biology laboratory addition, 108–F Building, Hanford, $300,000; additional animal-holding facilities, University of Tennessee, $235,000; animal bioradiological laboratory, Berkeley, Calif., $500,000; biochemistry laboratory, Oak Ridge National Laboratory, $487,000; low-level radiation experimental facilities, Oak Ridge, $242,000.

Then we have miscellaneous minor projects, $119,000. This totals $3,005,000. We utilized all of the funds available in 1960.

Representative HOLIFIELD. Does this program include the measurement of radiation in agricultural materials and that sort of thing or does that come under a different subject?

Dr. DUNHAM. This is construction for laboratory facilities related to that.

Representative HOLIFIELD. Where the testing would be done?

Dr. DUNHAM. No. These are not actually biochemical laboratories, as such, although some of the Hanford work will be related to the actual measurement, utilizing this extra space we are getting for them with that money which we had available in 1960.

Representative HOLIFIELD. You will maintain all of these from the operating fund?

Dr. DUNHAM. That is correct.

Representative HOLIFIELD. I notice that you asked for $8 million so the Division request was twice as much as you received. You must have envisioned a much more complete program than you are going to be able to have.

Dr. DUNHAM. The only item of that extra funds which is not actually replacement, or consolidation of work which is now going on, which can go on without this, is one which we hope some day to have, a radiobotany facility.

Mr. RAMEY. How much is that estimated to cost?

Dr. DUNHAM. That is estimated at $1,250,000.

Mr. RAMEY. Does that tie in with their experiments on genetic changes in wheat?

Dr. DUNHAM. Yes. This is something which grew out of an ad hoc committee which was set up to review our radiobotany program, our plant science program. They came up with certain rather than definite recommendations, one of which was that we should concentrate this effort largely at Brookhaven where they had a good, strong program; that some of the others we ought perhaps to phase out, at least for the time being; but this would require a facility at Brookhaven National Laboratory.

Mr. RAMEY. And the other funds would be just for improvements to existing facilities?

Dr. DUNHAM. They were such things as a request, for instance, from Berkeley for a new building to house the Donner Laboratory group. They have a perfectly satisfactory building now, so I would say this would not be urgently needed. I think there is the problem that some day the university may take over that building for some other purpose.

Mr. RAMEY. They are down the hill from the rest of the laboratory.

Dr. DUNHAM. That is correct. They are right on the campus.

Mr. RAMEY. Would they have built this new facility farther up the hill?

Dr. DUNHAM. It would be up where the new animal facility is that we are building this year for them. The animal facility is built for two reasons: One, they needed more space; and, the other, the existing facility is right in line with the beam. So it is not satisfactory for animals.

Representative HOLIFIELD. Does it have to be moved?

Dr. DUNHAM. We are going to keep the building there. We will have some animals in there as control animals, simply as long as it can be used to see what effects the scattered radiation in that general area is. But that will be just a minor effort.

Mr. TOLL. Does the Public Health Service resist or oppose any of these projects to be undertaken by the AEC on the theory that they should be doing this work rather than AEC?

Dr. DUNHAM. No, sir. I went over these items and the budget as a whole with Dr. Webber, and I am familiar with his budget request. We both feel that the two programs together are quite essential, and that there is no reason for one group phasing out at this point. There is just too much work to be done.

Mr. TOLL. Do you have interchange of personnel? Do some Public Health Service people use facilities at AEC laboratories?

Dr. DUNHAM. Not a great deal in the experimental biology field, but there is a good deal of exchange in studies on waste disposal and that type of thing, where Public Health Service people are assigned to Oak Ridge and other places like that, both for assisting with our programs and getting training.

Mr. TOLL. Thank you.

Representative HOLIFIELD. Would you give us or furnish the staff with a copy of that ad hoc report on botany?

Dr. DUNHAM. Yes; I think we can do that.

(The material referred to follows:)

REPORT OF THE COMMITTEE ON RADIATION BOTANY TO ADVISORY COMMITTEE ON BIOLOGY AND MEDICINE, AEC

INTRODUCTION

We the undersigned committee are honored to have been asked to survey the radiation botany research of AEC, especially at the national laboratories, and we submit our report herewith.

The study of the role of AEC in radiation botany was initiated at the November 1958 meeting of the Advisory Committee on Biology and Medicine of the Division of Biology and Medicine. It was voted to ask J. G. Horsfall, a member of ACBM, to chair a committee of botanists to be appointed by the American Institute of Biological Sciences under its contract with the Division of Biology and Medicine. We would like to express our appreciation to Dr. Hiden Cox and his staff for their assistance to us in all stages of our deliberations.

We are particularly grateful to the Washington staff of AEC and the personnel at the national laboratories for their gracious assistance to our committee.

OUR UNDERSTANDING OF THE CHARGE GIVEN TO US

We understand from Messrs. Shilling, Zelle, and Liverman that the duties assigned were (1) to appraise the present support of research in radiation botany sponsored by the AEC, especially at the national laboratories, (2) to determine whether emphasis on radiation botany should be increased, and if so, where, (3) to determine whether the change should be quantitative or qualitative or both, and, (4) to suggest an organizational pattern needed, if any.

OUR UNDERSTANDING OF THE RESPONSIBILITY OF AEC IN PLANT SCIENCE

Before proceeding to our task, we had to determine the responsibility of the AEC in the area of plant science. Our recommendations below stem from the following statement of our understanding of the responsibility of AEC in plant science:

1. To use all kinds of plants as experimental organisms to aid in understanding radiation effects, especially radiation damage to living organisms.
2. To learn the role of plants in the fallout problem, and the whole problem of internal emitters.
3. To consider the role of plants in the waste disposal problem.
4. To encourage use of isotopes as research tools.
5. To stimulate the teaching of radiation techniques, and, thereby, to increase the number and competence of scientists working in these areas.
6. To encourage the peaceful uses of atomic energy.
7. To conduct developmental research.
8. To conduct basic research.
9. To encourage graduate and post doctoral students in the field of radiation biology.

Use of plants as experimental organisms

We feel that the study of plants has contributed much to our understanding of radiation effects at the molecular level of research. On the other hand, we feel that research on plants at the organ, organ system, and community level is receiving much less attention than it deserves. We feel that research at these levels would be very productive to AEC in yielding basic information because the systems in plants differ drastically from those of animals, and, therefore, will produce significant data by the very nature of these differences.

Role of plants in the fallout problem

The problem is under investigation, but the need for data here is urgent if AEC is to answer the questions that will inevitably continue to rise in the minds of citzens and Government officals. Vastly more data are needed in the area of absorption, incorporation, cycling, and excretion by plants. Do species differ? Does microclimate, soil type, pH, other nutrients, etc. affect these matters?

Role of plants in waste disposal

The problems here are similar to those above, but those involving plant communities are even more important, and if possible, more pertinent. Whenever

waste is disposed, it is capable of moving in the environment—where, when, how—movement of seeds, leaves, and other plant parts by wind, or water, eaten by animals—birds, fish, earthworms, mammals. Do different native species absorb radionuclides differently, and do different ecosystems act differently?

The need for data here will increase fantastically as peaceful reactors multiply.

Isotopes as research tools

The use of isotopes as research tools has been abundantly encouraged by AEC. Biology is vastly the richer thereby but this phase of the operation seems drawing to a close because biologists are now well aware of the potentialities of the various methods. We see no need for increased support or promotion in this area.

Teaching of radiation techniques

Likewise, the teaching of radiation techniques has been well handled and we wish to compliment the DBM for this phase of the work. It had to take precedence. Most of the data needed by AEC to discharge its responsibilities in radiation effects, can only come from those men so taught.

To encourage peaceful uses of atomic energy

We have not explored this function of DBM very thoroughly, but we are impressed with the diversity of offsite projects which increase our fund of basic information, with the impact of the Brookhaven gamma field on plant breeders around the world, and with the progress of the work on radiation to preserve foods. We are impressed with the work on the eradication of insect pests with radiation-induced male sterility. Perhaps, this principle could be extended to weed pests such as the klamath weed in the West or even to crabgrass.

This phase of the work could well be expanded.

To conduct developmental research

Much of what has been said above involves developmental research. We feel that the national laboratories have seriously neglected this phase of the problem, or, perhaps, that they have not been given specific problems for which answers are needed, e.g., the Sr^{90} problem. We feel that it is to the national laboratories that AEC should turn in obtaining answers that are needed even before they are demanded by taxpayers and before they are reflected in the newspapers and in congressional hearings.

We fear that the developmental research is not keeping abreast of the basic research to be discussed in the next paragraph.

To conduct basic research

The Division of Biology and Medicine is to be complimented on the very large volume of basic research which it is supporting and which in the long run will best solve the problems that confront biology in AEC. Basic research is well in hand especially at the molecular level of biology where the ultimate explanation of radiation damage may well lie. On the other hand, we feel that AEC also needs a large expansion in basic research in organs, organ systems, and community effects of plants in order to answer pressing problems.

And finally, we suspect that perhaps one reason for the incompleteness of the coverage listed in the paragraphs above, where it is incomplete, is due to the origin of projects supported by AEC. We understand that by and large the projects are proposed by workers in the national laboratories or in the universities and presumably these men have not proposed a sufficient number of projects in the areas of need.

OUR RECOMMENDATIONS

1. One of the specific charges given to our committee was to consider the feasibility of establishing a radiation botany institute at Argonne. After giving very careful consideration to this proposition, we believe that it is unworkable. We believe that South American society needs many things before it needs a Radiation Botany Institute. We think there are many things that would put food into the bellies of peons more quickly and more certainly than by setting up a very sophisticated research institute in radiation botany. Other reasons for disapproval of the Argonne proposal are that DBM does not have a primary responsibility for the uplifting of botany, that the DBM has no mandate to enter the agricultural field, that it is not an instrument of foreign policy, and that it should not compete with universities as an educational insti-

tution. If the DBM can foster these aims incidentally and indirectly, this is well and good, but it should stick to its prime responsibility of being concerned with the biological consequences of radiation, and only after it has fully discharged this responsibility should it look for greener pastures.

Moreover, we are convinced that Argonne is not botanically oriented. Thus, to set up a radiation botany institute there would involve an entirely new organizational scheme which would be more expensive than the results would justify. With further regard to Argonne, we would suggest that the work on tagged plants at the isotope farm and the ancillary functions be discontinued. This work having been pioneered can be certainly done by others on their local grounds more readily than it can be done at Argonne.

2. We do suggest, however, that AEC set up several organizational units qualitatively somewhat different from those we saw that are presently being supported by AEC. We use the phrase, "qualitatively different" because, as noted above, we have found that organs, systems, and communities of plants are not yet adequately treated.

3. We suggest that these organizational units be charged as follows:

(*a*) To emphasize research on radiation effects, especially radiation damage, rather than radiation usage.

(*b*) To give a special emphasis to organizational levels of plants, including organs, tissues, whole plants, and plant populations. This should be done without in any way deemphasizing molecular biology which is so well covered in the existing organizational pattern.

(*c*) To emphasize ecology and mineral nutrition of plants of all kinds as related to the fallout and the waste product problems. Here, we recommend much more attention to the soil and its role.

(*d*) To discourage and test chemicals to combat radiation damage, to discourage uptake of isotopes, or to encourage excretion of isotopes from plants.

(*e*) To deemphasize in these units the promotion of isotopes as tools. We think that AEC has done a superb job in this field, but that others are using research isotopes now in an extensive fashion and perhaps AEC's role here could stand some deemphasis. Obviously the organizational units we recommend would use isotopes as research tools, but would not devote quite so much effort as in the past to the mere promotion of them as tools.

(*f*) To limit the training function of the nonuniversity organizational units to the graduate and postdoctoral level; that is to say we suggest they do not compete with the universities for training undergraduates through formal courses.

(*g*) We suggest that one of these organizational units be established at Oak Ridge and that the work there on the community of plants be very greatly increased in magnitude. We suggest that any germane sections of Hollaender's unit be transferred to the new unit, or that the unit be made a section of Hollaender's organization and that it include the work of Hall and Auerbach. In fact, we would recommend that Auerbach's unit be transferred bodily to the new unit.

We were impressed with Hall's qualities as a leader and would offer the tentative suggestion, at least, that perhaps Hall would be the person to put in charge of the new unit. We recognize that there may be administrative problems in respect to the University of Tennessee, but we would assume that these could be ironed out. We suggest also that another organizational unit be set up at Brookhaven to deal with plants at the organ and tissue level in contrast to the community level at Oak Ridge. Molecular biology at Brookhaven is well organized and flourishing but we feel that the research at the organ-tissue level should be greatly increased there. We recommended further that botanists be given more say in program planning in radiation biology at Brookhaven.

(*h*) We recommend that several such organizational units be established at competent universities, preferably distributed over the broad areas of botany, in order that they encompass problems concerned with various ecological situations, i.e., one in marine, desert, forest, grassland, and Arctic areas. Certainly one or more of these units could well emphasize phytophysics because this area of research is neglected somewhat in favor of phytochemistry.

4. We recommend that the Division of Biology and Medicine encourage in the Washington office the establishment of machinery for initiating projects in the neglected areas. We suggest that there is urgent need for someone on the staff at the policy level who can be freed from paper work to give the

radiation botany situation a penetrating and continuous survey for the purposes of—

(*a*) Detecting gaps in the research program,

(*b*) Searching out personnel in the national laboratories, in universities, and in industry to investigate problems of special interest to the AEC, and

(*c*) Ascertaining the current status of any problem or question when the need arises.

Items (*a*) and (*b*) require the talents of a scientist conversant in biology as a whole and with special responsibilities of the Division of Biology and Medicine; Item (c) requires some device (contract or otherwise) whereby the DBM could be brought up to date on particular areas of interest through the medium of subsidized reviews or surveys made by competent scientists.

5. And finally, we suggest that AEC should maintain and expand the present system for encouraging project initiation by others because this will emphasize the continued use of basic research that is needed to complete the mission of AEC. Also the maintenance of this system would insure the continuation of the mechanism for obtaining good ideas from outside Washington.

Respectfully submitted.

ALLAN BROWN.
JOHN CURTIS.
JAMES G. HORSFALL, *Chairman.*
PAUL KRAMER.
M. B. RUSSELL.
GEORGE SPRAGUE.
CARL SWANSON.

Representative HOLIFIELD. And a breakdown of this $4 million that you were denied, as to what you would have used it for.

Dr. DUNHAM. Surely.

(The material referred to follows:)

Division of Biology and Medicine—Listing of proposed plant acquisition and construction facilities totaling $4,000,000 deferred as a result of Commission budgetary review

Total	$4,000,000
1. Controlled environment facility for radiobotany, Brookhaven National Laboratory	$1,250,000
2. Photosynthesis and chemical biodynamics laboratory, Lawrence Radiation Laboratory	1,250,000
3. Additions and modifications to biomedical research facilities at Lawrence Radiation Laboratory	900,000
4. Installations for support of biomedical research projects at various locations	600,000

Representative HOLIFIELD. Mr. Ramey?

Mr. RAMEY. What is the Public Health Service doing now? Has their program been augmented any in this field?

Dr. DUNHAM. Not a great deal in experimental radiation biology. That work is largely under the National Institutes of Health. I am on the Radiation Study Section. That program has grown some, but not spectacularly. It is part of the total grant program of the National Institutes of Health.

What they are expanding quite rapidly is the public health part of their activity, particularly the laboratory facilities for surveillance of food products and that sort of thing, and water, air, analytical studies, and epidemiological studies of people who have been living in high background areas.

Representative HOLIFIELD. What is the scope of their program? How much are they spending in that field? Does it amount to very much?

Dr. DUNHAM. Their program is several million dollars, I believe, for fiscal 1960. But I believe they have gone in for more funds. With additional funds in radiological health, the figure I have here is as of last October, and it may have expanded some since then, is around $3 million. That is this current fiscal year.

Representative HOLIFIELD. Are they doing quite a bit of training?

Dr. DUNHAM. They are doing a great deal of training in personnel; yes.

Representative HOLIFIELD. Are there any further questions?

Mr. Hosmer?

Mr. HOSMER. No.

Representative HOLIFIELD. Mr. Toll?

Mr. TOLL. Dr. Dunham, do you run into any trouble on releasing any reports concerning health aspects? Does anyone within the AEC feel it would be improper to let this out? Do you have to suppress information that is developed in any of your laboratories?

Dr. DUNHAM. I am not aware of any at the present time; no. Maybe General Luedecke would like to speak to this point.

Mr. LUEDECKE. No; there is no opposition to the release of any report, or the results of our work in this regard.

Representative HOLIFIELD. Mr. Ramey?

Mr. RAMEY. You mentioned on the Public Health Service that they are doing these studies on the effects of natural radiation. That ties in with your studies on the effects of radiation, also, does it not?

Dr. DUNHAM. Yes. Actually, they, of course, have trained epidemiologists, which we do not, and we feel it is very appropriate that they develop a strong program in this area. You are familiar with the studies in Illinois of the high radium waters in the area, and we have not been able to find competent epidemiologists to make the epidemiological part of the study.

We are hoping when they get more people trained they will be able to move into this sort of a project.

Mr. RAMEY. Have they put out any reports on this?

Dr. DUNHAM. Of course, their biggest studies have been in uranium, which we have assisted with from time to time, both with funds and actual equipment.

Representative HOLIFIELD. Have they been concerned with those streams that were polluted by the mills out in the West?

Dr. DUNHAM. Yes, they have made studies of those mills, of those streams.

Representative HOLIFIELD. You both have been working on that?

Dr. DUNHAM. That is right. They have been funded from both agencies, those studies.

Representative HOLIFIELD. Is there any particular conflict in the findings of the two agencies?

Dr. DUNHAM. I do not know of any scientific conflict at all, so far as the data is concerned.

Representative HOLIFIELD. And how about the interpretation of it?

Dr. DUNHAM. Well, I think generally interpretation is pretty much the same between the two agencies.

Representative HOLIFIELD. Have you cleared up that situation out there as far as instituting or enforcing regulations that would prevent further contamination?

Mr. LUEDECKE. We believe that we have cleaned it up. It will take us another month or so of sampling to really pin down what the concentrations are. We have done a great deal of work. And the mill has done a great deal of work, with the installation of new settling basins and a filtration plant.

Our sampling indicates that it is down within the permissible limits. But it will take us a little more time to really analyze this to be sure that this is correct.

Representative HOLIFIELD. I had a letter from one of the Congressmen out in that area in regard to the dust in the mills, the danger of the dust. Has that situation been controlled?

Mr. LUEDECKE. It is in a similar situation. It is very difficult to say, Yes, it is under control. A great deal of work has been done to this end. We have our people actually, physically, in the mill now trying to determine whether the levels are brought down. But again, we will not know for sure for a little while yet.

Representative HOLIFIELD. It seems very important that that be taken care of. You will remember how many years the contamination by silicosis in the regular mines existed and how much damage it did for years and years. It was practically unrecognized.

After it was recognized, it was unregulated. We certainly do not want that kind of a history in this field, because I do not believe it is necessary to have it.

Mr. LUEDECKE. The Commission has made a very major effort in this line since about last July, particularly with respect to the mill, and in most cases a great deal of work is going on now with installation of ventilating equipment and filtering equipment to bring them within the standards.

It is a very difficult job to determine whether, in fact, they are within the standards. It takes many, many samples and much analysis and correlation, but we are making a very major effort to bring them in.

Representative HOLIFIELD. I suppose we will get a report on that as soon as you get the results of your sampling.

Mr. LUEDECKE. Yes, sir.

Representative HOLIFIELD. Are you participating in the Federal Radiation Council, either personally or by representatives?

Mr. LUEDECKE. Personally, I am not. The chairman, of course, is a member of the Radiation Council. We have members of the committee on the Radiation Council.

Representative HOLIFIELD. Is it actively working or having many meetings, or is it just one of these name agencies?

Mr. LUEDECKE. It has had some meetings. I do not remember the exact number, and its subcommittees have had a number of meetings.

Dr. DUNHAM. The Council has met a number of times; I think at least five or six times. They have established a working group with representatives of each of the agencies; and, under that, a working task group, you might call it, which has been meeting essentially full time for a matter of a month or more, trying to develop a statement in relation to basic standards. So they are working quite diligently at it.

Representative HOLIFIELD. I might call attention to the fact that we are going to have hearings on this in late May or early June, so I hope you are ready at that time to make a full report on it.

Let us go to the community projects.

COMMUNITY PROGRAM

Mr. LUEDECKE. Mr. Chairman, project 61–i–1, real estate development, Los Alamos, N. Mex., $435,000, is for the development of about 73 additional lots for sale to project-connected personnel at Los Alamos for homesites. The cost covers the necessary utilities, roads, appurtenances, and lot development. Barranca Mesa, which lies immediaely north and in proximity to the main Los Alamos community, has been designed to conform to FHA subdivision requirements as to physical improvements, utilities, and lot layout.

The subdivision enables Los Alamos personnel to build the size and type of house desired, and also provides an additional incentive for personnel to spend their full working careers at Los Alamos.

This project is the third increment of lot development on Barranca Mesa, the first increment being 72 lots which has just been completed, and all 72 lots have been sold. The development of a second increment of 47 lots has just begun. The average cost of development per lot is $5,959, and the average sales proceeds from the lots have been $1,804.

Representative HOSMER. Would you repeat that?

Mr. LUEDECKE. The average proceeds from sales have been $1,804 per lot.

Representative HOSMER. What was the figure you gave immediately preceding that?

Mr. LUEDECKE. The average cost of development per lot is $5,959.

Senator AIKEN. What is the average size of the lot? How large are they?

Mr. LUEDECKE. The average size, sir?

Senator AIKEN. How large are the lots?

General STARBIRD. They run on the average, sir, about 150 by 300 feet. They are not large lots.

Chairman ANDERSON. They are not that large, either. I do not think they are. Do you think so, General Starbird?

General STARBIRD. I do not think so.

Chairman ANDERSON. Some people have two lots, but most of them are ordinary single lots that would have about 10,000 feet of space on them.

Senator AIKEN. And they are sold to private owners?

Chairman ANDERSON. Yes, and they are being developed by scientists who hope to spend the rest of their working days at Los Alamos and then be able to enjoy some of the back country and mountains that they have been visiting for weekend trips and so forth.

Senator AIKEN. Is that good country?

Chairman ANDERSON. We think so. The deer run after you; you do not have to run after them.

Is it not true, General Starbird, that most of these houses have been somewhat above the average of a subdivision?

General STARBIRD. They certainly are, sir, and the people have used a great deal of care as well as a substantial part of their own funds to make this a very attractive community.

Incidentally, when General Luedecke was saying that this was the cost of the lot, this is the lot and all the utilities.

Chairman ANDERSON. I was just going to ask you that. Is it not true that some of this cost will be recovered over a period of years?

General STARBIRD. That is correct.

Chairman ANDERSON. In fact, eventually the entire investment of the Government will come out of it through the increased charge for utilities.

Mr. LUEDECKE. We estimate that the full remaining cost of $4,155 will be recovered through the annual utility charges over a period of a little over 16 years, to provide full recovery.

Representative HOSMER. What is the average construction cost of these houses that have been put on the 72 lots already sold?

General STARBIRD. I would have to guess, sir. I would guess that it averages in the neighborhood of $25,000.

Representative HOSMER. $25,000?

General STARBIRD. Yes, sir.

Representative HOSMER. That is on a $2,000 lot?

General STARBIRD. On a $5,000 lot.

Representative HOSMER. Do they not get their lots for $1,800?

General STARBIRD. Yes, sir; they get it at the appraised value of the lot, but the actual cost of the lot and utilities is of the order of $6,000.

Representative HOSMER. I realize that.

There is a $4,200 differential between the cost of improving these lots and what they are sold for, and the value, if any, of the property, itself, is included or disregarded?

General STARBIRD. I do not think I quite understand you.

Chairman ANDERSON. I think it would be better to say, Mr. Hosmer, that in an ordinary municipality you vote a 25-year bond issue and you retire it in installments covering the period of 25 years. But you only would pay for the lot $1,800. In this you pay the $1,800 and there is also charged against it the full cost of the utilities that have gone in there and you pay that in a series of equal installments, just as you do for a bond issue against it.

But there is no way of bonding the Government property, so a subsequent assessment is made year by year to take care of the extra cost.

Would that be your understanding?

General STARBIRD. That is my understanding.

Representative HOSMER. That is not exactly my understanding from the position where a developer takes land and improves it for subdivisions. Then the cost of the lots reflect not only the original price of the land, but the cost of improving it in accordance with FHA specifications. That is the general situation.

Chairman ANDERSON. Not necessarily. I have one on my farm and it is not working that way there. I do not wish to prejudice the sale of lots on the farm, however. But eventually a municipality moves in and it has a general bond issue. It may be different in different communities, but in my home city of Albuquerque, the city owes some $30

million, and people who bring their areas in eventually will take a portion of that.

In Colorado Springs, if you subdivide and bring a new section into the city, you automatically assume $1,500 per acre, as I recall it, that goes against you in installments over a long period of years, just as this $4,000 does.

This is a little higher, because this is difficult development. This is not easy. You are bringing gas lines a long ways and you have problems of sewage and so forth that you do not have in an ordinary area.

But I only want to say that I think the subdivision has been a great success, and from the standpoint of the Government it is not going to be expensive over a period of years.

Representative HOSMER. I do not wish to quarrel with the Seantor from New Mexico on this, because I am fairly familiar with the situation there. But I think, realistically, possibly we would have difficulty in finding another location in the country where you can get a lot to buld a $25,000 house on for the sum of $2,000. I think it may not be realistic in that sense, but it is probably realistic in the sense of the isolation of the community and the purposes to be accomplished.

Chairman ANDERSON. I would have to agree with you, Mr. Hosmer, that that is a lower figure than you would normally expect. The usual figure, I think, of 20 percent of the house might go into the lot, and, therefore, you might expect the figure of somewhere in the neighborhood of $4,500 for a $25,000 house.

Eventually these people will have about that. I think when you say the average is about $25,000, I think the figure may be correct, but two or three very expensive ones have added to that figure. The average house is costing around $14,000 or $15,000, up to $20,000. I think you could count on the fingers of one hand the houses that cost more than $20,000.

Representative HOSMER. I would like to ask one more question. When they fix these lots up, are they tearing out all the trees and leaving nothing but that dust to be blown around or have they changed their policies?

General STARBIRD. There is no skimming of the land here. Generally these houses are out on a mesa which is, at the present time, without trees. As you know, the area that is available still for housing is quite small, and it was necessary to run utilities in, roads in, quite a distance to serve this area so that we could get an area that could be attractively developed. To answer your question, we are not skimming.

Representative HOSMER. I had the same question in mind that Senator Anderson had, about the size of these lots. What are they—about 150 by 300?

General STARBIRD. I will certainly correct that for the record. I think Senator Anderson is probably right. He conducted a very extensive hearing there.

(The material referred to follows:)

Average lot sizes for the Los Alamos real estate development program are:

Project No.	Number of lots	Average size
		Square feet
57-j-1	72	19,800
60-k-2	47	20,400
61-l-1	73	18,000

These lots run somewhat less than a half an acre and are approximately equivalent to lots of 100 by 200 feet dimension.

Chairman ANDERSON. We had a fine hearing, General Starbird. Representative Bates of Massachusetts was along, and Senator Bennett was along.

As you know, Senator Bennett is a most competent businessman. He asked a number of searching business questions, not only during the inspection, but during the hearing.

I would be happy if, sometime later, Senator Bennett had a chance, and Congressman Bates, too, to express themselves, because I think they were both well satisfied with the development. It will cost the Government something, but, by the same token, bringing a new scientist in and releasing an old scientist also costs the Government a great deal of money.

This has been a most stabilizing influence. There are some people who do not like it. I have just turned over to the Atomic Energy Commission a letter from a man up there who complains about the lack of private and VA financing, and so forth, in the area, which they are trying to correct. I do say that some of the houses that have been built are not houses that would answer to the normal financing requirements.

They are better houses, by quite a little bit. They represent what some of these scientists have saved by living up in that community. As Mr. Hosmer himself lived there for a great many years, he knows that some of these men have put in their lives in the laboratories and have done very little outside of that.

But the standard of the house is an extremely satisfactory one, and some of them are most attractive, very attractive.

Representative HOSMER. I would like to ask one further question.

Has a satisfactory means been worked out, a generally satisfactory means, of allocating these lots for purchase?

General STARBIRD. Yes; there has been. Actually it was on a draw basis. There was a slightly greater interest, that is, interest in drawing, in the first group than there were lots available. In the second group we have a large number more in the second group of about 40 lots, who want to come in and draw on the next group.

The thing is really just rather catching fire. People are just beginning to see the houses out there, to see that it is a chance for an

attractive development and, from our point of view, the quite selfish point of view, this is a way of keeping people happy and giving them the type of house that they need.

Chairman ANDERSON. I think I would say, Mr. Hosmer, that in the first drawing a lot of people worried because there were a couple of double lots permitted, and they said, "We would have had a house if you hadn't given that double lot to one individual"; but it is the double lot that has attracted other people out there.

General Starbird, is it not correct that there was less complaint, even though not as many people drew, less complaint over the drawing method on the second allocation than probably on the first?

General STARBIRD. The formal drawing we have not made yet, but this is right, that the system being set up is certainly a system that has not led to any severe complaint.

Representative HOLIFIELD. I have one question before we go to the next item.

Is this differential charged specifically to each lot so that it does become a lien?

General STARBIRD. No, sir; it is not.

Representative HOLIFIELD. It is a general charge for the utilities that will net enough profit to discharge the cost?

General STARBIRD. That is right.

Representative VAN ZANDT. Mr. Chairman, unfortunately I was not able to attend the meeting that was held at Los Alamos last fall?

What is the situation as far as the shopping area is concerned? Have you disposed of all the buildings?

General STARBIRD. No; we have not. We have all buildings occupied. They are occupied on a concession basis. In addition to that, we are trying to start and actually have started a system whereby land suitable for community-type operations would be rented on a long lease basis in an attempt to encourage private storekeepers, gasoline station operations, and the like, to come up and put in their own installation.

Representative VAN ZANDT. Have any families other than the families of an employee moved into the area and either bought or built real estate?

General STARBIRD. None could, sir.

Representative VAN ZANDT. It is still restricted?

General STARBIRD. It was restricted in the original purchase to project-connected people. The people that are there have all indicated a stability and desire to stay there. It was impossible to restrict the lots as being forever project connected.

Representative VAN ZANDT. How about your businessmen who have moved in? Are they permitted to buy or build real estate?

General STARBIRD. They are permitted, sir. They are permitted to make their bid for a lot.

Representative VAN ZANDT. In other words, Los Alamos, from a community standpoint, is still expanding?

General STARBIRD. It is but slightly. It is not expanding as fast as we would like to see it. That is the reason for this effort. There are still a great many people who would be eligible to live there, and who are project connected, who cannot get houses.

Representative VAN ZANDT. That is all, Mr. Chairman.

Representative HOLIFIELD. Project 61–i–2.

Mr. LUEDECKE. This is an elementary school addition at Los Alamos, $145,000. This would provide for an addition to the Mountain Elementary School of four special-purpose classrooms having a total area of approximately 7,200 square feet. The need exists for additional elementary school classrooms and additional space for library, music, art, and industrial activities at the Mountain Elementary School.

The addition will make it possible to convert two rooms now used for specialized instructions back to regular classroom use to meet the forecasted increase in enrollment. By the time the addition is completed, it is expected that the enrollment of this particular school will have increased by something like 100 students.

Senator AIKEN. May I ask: Does that cost include furnishings?

General STARBIRD. It does include the fixed furnishings.

Representative HOSMER. This is about $20 a square foot. Is that comparable to elementary school construction costs elsewhere in New Mexico?

General STARBIRD. The actual building is about $13 per square foot, and the equipment is the additional. I cannot answer your question, sir. But I can furnish that information for the record. It would sound about like it to me.

(The information referred to follows:)

Elementary school building construction costs averaged $11.50 per square foot in Albuquerque, N. Mex., in 1959. Construction costs at Los Alamos normally run 10 to 15 percent higher than in Albuquerque, due to its remote location. The total project with equipment included is $20 per square foot.

Senator AIKEN. That total area for four rooms is 7,200 square feet, one-sixth of an acre.

General STARBIRD. Here, again, with the school system we have tried to go forward only as fast as the increase in the number of students. Year after year there has been a slight increase necessary in the school.

We try to adjust to the children in the school as far as possible to keep from building too much. The current school population is about 4,100 and it is expected to go up to about 4,350 by the end of fiscal year 1961.

Representative HOLIFIELD. Does the Government furnish the salaries for the teachers, or does the New Mexico State Board of Education?

General STARBIRD. It is on a split basis, sir. It is paid for about 60 percent by the State. The State contributes toward this school the same as it would contribute toward any other school, and the additional is paid for by the Government from an Atomic Energy Commission appropriation instead of through an impacted area appropriation.

Representative HOLIFIELD. In lieu of using the impact grant?

General STARBIRD. That is right.

Representative HOLIFIELD. The next project is 61–i–3.

Mr. LUEDECKE. This project is a steam-transmission line at Los Alamos, N. Mex., of $135,000. It will provide for the construction of about 3,500 feet of steam line to connect with a new steamplant recently erected within the technical area.

The community is currently served by a small steamplant built in 1948. The cost of producing steam in the new plant is 31 cents per

1,000 pounds, as compared with $1.51 per 1,000 pounds in the smaller plant.

When the project is completed, the small steamplant will be placed in standby. The use of the steam from the new plant will reduce the annual operating cost by about $45,000.

Representative HOLIFIELD. Is this steam for the different plants there, the different AEC laboratories and plants?

Mr. LUEDECKE. Yes, sir; it serves all of the community as well as the technical area.

Representative HOLIFIELD. Mr. Ramey has a question on the steamplant.

Mr. RAMEY. Has any consideration been given to using atomic facilities to generate steam?

Mr. LUEDECKE. We did, Mr. Ramey, about 3 years ago consider whether the art at the time and as being carried forward in that locality warranted putting in a reactor which would serve both the power and the steam requirements.

At that time, because of an urgent need to get forward, and not having a design on the shelf that we wanted to use, we ran the transmission line up from the valley. This was a way of getting the power that we needed rapidly.

As of the present moment, there is no plan under active consideration for placing an operating reactor there.

GENERAL PLANT PROJECTS

Representative HOLIFIELD. We had some testimony on the general plant projects. Was there anything that you wished to elaborate on in that regard at this time, General Luedecke?

Mr. LUEDECKE. I believe not, sir, unless there are questions. They are in line generally with what we have found from experience before.

ZERO GRADIENT SYNCHROTRON

Representative HOLIFIELD. We will go to page 8, section 107, and take paragraph (a).

Mr. LUEDECKE. This is the zero gradient synchrotron, Argonne National Laboratory. We are requesting the authorization to be raised $42 million. This project is to provide for the design and construction of a high-intensity high-energy proton synchrotron and related laboratory and experimental areas at the Argonne National Laboratory.

Authorization for this project was approved at $27 million in the 1958 authorization act. The last cost estimate submitted to Congress was $29 million, included in the fiscal year 1960 congressional budget submission.

A recent review of the project indicated that additional high-energy physics facilities associated with the machine should be provided now. These additional facilities need to be constructed simultaneously with the basic project in order to utilize as soon as possible the machine's full potential and in order to avoid interference with the operation of the machine that would occur if these items were to be delayed.

The increase in authorization to $42 million will provide for significant additions to the experimental facilities and related power supply, cooling systems, and machine controls. The major items of these additional facilities include modifications to the meson shield wall; extension of external experimental proton areas, areas A–1 and A–2; power building for the meson area and proton area A–1; power building for proton area A–2; cooling system addition; additions to the main substation; additions to the main power building; additions to the shop and assembly building; slight improvements in utility extension; additional machine and beam control; a bubble chamber building; and a cyrogenics facility.

Representative HOLIFIELD. Does this increase the parameter of this particular accelerator to higher ranges?

Mr. LUEDECKE. No, sir; not to higher ranges. It is to provide greater utility.

Representative HOLIFIELD. And the utilization?

Dr. MCDANIEL. It would still be the same accelerator, with the same intensity per section.

Representative HOLIFIELD. Your design is 32 percent complete and the construction is about 3 percent, so you are really just getting started on the construction.

Dr. MCDANIEL. Those figures were as of last October 31. I think they would be a little higher now. The construction is on schedule. The physical construction is now scheduled to be completed June 30, 1962.

Representative VAN ZANDT. Mr. Chairman——

Representative HOLIFIELD. Mr. Van Zandt.

Representative VAN ZANDT. The other day when Mr. McCone was before the committee we discussed this project at the Argonne National Laboratory, and at that time I indicated my deep concern about the Laboratory and office facilities.

I am of the opinion that we should not wait to get the authorization of a laboratory and office facility. This project impressed me considerably mainly because of the importance of our exploring the field of high energy physics. If we wait another year or 2 years, will we deny this facility its full potential through the lack of laboratory facilities and office facilities?

Mr. MCCONE. It is the opinion of the Commission and the staff that we would not.

Representative VAN ZANDT. Do you plan to ask for authorization next year or the year after that?

Mr. MCCONE. Do you mean in 1962?

Representative VAN ZANDT. Yes.

Mr. MCCONE. We have not formulated our authorization legislation for 1962 as yet. But certainly it will come under consideration.

Representative HOLIFIELD. In the meantime, the facilities you have are usable, that is, your office and administrative area, and so forth?

Mr. MCCONE. We feel so.

Representative HOLIFIELD. They may be old, but they are adequate?

Mr. MCCONE. We feel so.

Representative HOLIFIELD. It should not cut down on this particular facility, the use of this in any way; should it?

Mr. McCone. No. As I explained the other day, the reason we are asking this authorization is so that in the design of the facilities that have already been authorized and funded, appropriate engineering changes can be made with assurance that these additions will go forward when needed. Failing to make this authorization, the engineers would be prompted to build the facility as presently authorized, and then the modifications would be extremely expensive, if not impossible, if attempted after the facility had been constructed.

Representative Holifield. How much do you estimate this would increase the usefulness of this particular facility, by making this change now, in terms of additional workload?

Dr. McDaniel. It is, of course, very difficult to attach a figure to an item like that, but it certainly will permit the full utilization of the two proton beams under a sheltered, closed area. It will permit the full capabilities of the meson beam to be developed properly.

I would have to say, in answer to your question, it would greatly increase.

Representative Holifield. The additional takeoff avenues, and so forth?

Dr. McDaniel. Absolutely; yes, sir.

Representative Holifield. So you could actually handle a number of additional experiments off of the same beam?

Dr. McDaniel. One particular addition will be the control mechanism for being certain that the machine is properly phased for each experiment. It will be an automatic type of control. Without that control, a great deal of hand labor would have to go into each particular experiment. The programer will certainly provide for greater flexibility of operation.

The additional power facilities are needed to provide additional cooling for the machine. It happens that in the Chicago area, because of high temperature and high humidity, the machine could not operate for about 150 hours a year within the present authorization.

The additional cooling facilities will allow the magnet to be cooled so that it may be operated continuously throughout the year.

Representative Van Zandt. Mr. Chairman——

Representative Holifield. Mr. Van Zandt.

Representative Van Zandt. General Luedecke, what is it going to cost us to operate this synchrotron annually?

Dr. McDaniel. It is estimated that at about 1965 the cost of operations, including the equipment for the operation of the 12.5-Bev. synchrotron, would be about $15 million.

Representative Van Zandt. What is it costing us to operate Brookhaven?

Dr. McDaniel. For the same year, we estimate that about $15 million will be the expenditures at Brookhaven for operations and equipment for the two machines there.

Chairman Anderson. Operations and equipment? Why not confine it to operations?

Dr. McDaniel. The operational budget.

Representative Van Zandt. Will you state those figures again?

Dr. McDaniel. For the Argonne National Laboratory, about $15 million, and for Brookhaven National Laboratories, about $15 million.

Chairman Anderson. Would the gentleman from Pennsylvania yield?

What was the anticipated cost of the Argonne facility at the time it was constructed? What was it then estimated it was going to cost annually? Was it somewhere in the neighborhood of $6 million?

Dr. McDaniel. I did not get the Senator's question.

Chairman Anderson. Originally there was an estimate before it was built as to what it was going to cost to operate per year. Was that not about $6 million?

Dr. McDaniel. It would be of that order of magnitude. I do not have the figure.

Chairman Anderson. What about Brookhaven? You have two there. You anticipate about $15 million. Is that divided into the two?

Dr. McDaniel. That is correct.

Chairman Anderson. $4,600,000 for one and the balance for the other?

Dr. McDaniel. Yes.

Chairman Anderson. What was the original estimate of those, about $1\frac{1}{2}$ million apiece?

Dr. McDaniel. I think about 5 years ago, sir, when these machines were originally proposed, the estimates for operation were of the order of a few million dollars.

Chairman Anderson. The only reason that I asked the question is that we have had some discussion of this with members of the Commission, and we have all tried to come to what might be a sensible point of view on these things.

It involves the Stanford accelerator and various others. Has your general cost gone far beyond what you anticipated when these were originally proposed?

Dr. McDaniel. Yes.

Chairman Anderson. What are the reasons for that?

Dr. McDaniel. The reasons are perhaps threefold. First, when the original estimates were prepared, they were based on the then current economic situation, so there has been some escalation. A second reason: When the original cost estimates were prepared, there were some errors in estimating. They were obviously estimated low in some cases. The third reason, and I think probably the biggest factor, has been the advance in the technology of using these machines, the inventions of additional detection apparatus which permit fuller utilization than previously had been thought possible.

For example, when the cosmotron and the bevatron were initially authorized by Congress and constructed, there was no detection apparatus other than Geiger counters or photographic emulsions. In the intervening years, detectors such as bubble chambers have been invented and have been shown to be instruments of great utility.

The bubble chambers, themselves, cost a great deal to construct and operate. The addition of these costs to the original estimates have perhaps influenced the discrepancy between the earlier estimates and the present estimates more than anything else.

Chairman Anderson. I am sorry, but I understand there was a request made yesterday that we do not go too deeply into this until the Chairman of the Commission has a chance to come up and present it. I did not mean to run contrary to that.

I was only trying to point out that the committee has responsibility for authorizing these appropriations and has a responsibility to

look to the ultimate cost and not just the initial suggested cost. These have gone pretty far out of line. Therefore, the Commission and the committee would be perhaps justified in taking a little firmer look than just the glowing representations that might be made for some of these projects now. They are all useful, but we have found a whole host of new uses for each one of these.

Dr. McDANIEL. I think this is the big fiscal problem; yes, sir.

Chairman ANDERSON. Therefore, the cost goes up with extreme rapidity. I just want to say on the record and for the record that nobody could have been more alert to this in calling it to the attention of the Joint Committee than the Chairman of the Commission, Mr. McCone.

I, for one, am deeply grateful to Mr. McCone for pointing out to us that you do not just take a look at what the first cost seems to be, but what the ramifications of science may finally produce in the cost of one of these operations.

Representative VAN ZANDT. Can you give us an estimated cost of the Stanford machine, if it is ever built?

Representative HOLIFIELD. May I say, Mr. Van Zandt——

Representative VAN ZANDT. I want the figure to compare with these other two.

Dr. McDANIEL. The testimony that was given before this committee last summer during the Stanford hearings indicated that about $15 million would be the annual operating level. There has been some reconsideration of this figure. It may be perhaps higher.

Representative VAN ZANDT. Is it not true, then, that while these machines are not identical in output, yet the cost of operation is somewhat comparable due to the fact that all three of them operate in different fields of activities? Is that correct?

Dr. McDANIEL. It seems to be correct, when you look at the numbers. I think perhaps this is a set of circumstances rather than any fundamental reason for them being about the same. The machines are somewhat different. They take different numbers of people, different types of instrumentation. I think the fact that they each turn out to be about $15 million a year is a coincidence.

Representative VAN ZANDT. Thank you.

Representative HOLIFIELD. I think the other side of this coin, in looking at these increased costs, is that you have a tremendous capital investment there, and if additional scientific uses such as this bubble chamber and these other things come along, certainly I think we ought to take advantage of them rather than to deny ourselves the future scientific developments that might arise from these new use discoveries.

It is a tool that has more uses than we thought it had when we first made it. It seems this is somewhat of an offsetting factor to the increased costs of both these changes and the operational cost.

Dr. McDANIEL. We think, sir, you are absolutely right.

Representative HOLIFIELD. If there is a new use for it, it is just as much justified as the original use was, if it is of equal or greater scientific value.

Dr. McDANIEL. We are perfectly willing to come before this committee and face your ire because we believe that the additional research is fully justified and that the costs are fully justified, too.

Representative HOLIFIELD. The thing we are concerned with, as Senator Anderson said, is that we start on one of these and it seems to go up, both in capital cost by changes and also in the cost of operation.

In line with this $105 million accelerator at Stanford, we wonder if you start at $105 million if you are going to end up at $200 million.

Dr. MCDANIEL. Perhaps during the later hearings before the committee we can explain this. I believe our experience on these other machines will help us in preparing a better estimate on the Stanford accelerator.

Representative HOLIFIELD. We are going into that in more detail as soon as reports are available.

Representative HOSMER. Again speaking from the same side of the tossed coin as Mr. Holifield, the design of this particular machine in relation to capital cost would have cost infinitely more if the previous design had been used. This is a capital-cost-cutting design, as I understand it; is that right?

Dr. MCDANIEL. Yes, sir.

Representative HOSMER. You get a good deal more for your dollar in terms of intensity and force than you do with the older.

Representative HOLIFIELD. It is a capital cost, but the ratio of value appears to be greater to the dollars; is that right?

Dr. MCDANIEL. That is correct.

Representative HOSMER. If it was considered in cost per kilowatt as we do powerplants, it would be a cut down in the cost.

Representative WESTLAND. Is there anything comparable to this any place else in the world?

Dr. MCDANIEL. There is no machine under construction that I know of, and I believe we have good information. There is no machine, a 12.5 Bev. proton accelerator, of the high intensity of this machine; no, sir. It would be a unique machine and highly applauded by the scientific community.

Representative HOLIFIELD. Are there further questions on this?

If not, we will pass on to section (b).

At this time we will ask Admiral Rickover to come forward.

ALTERATIONS TO SHIPPINGPORT REACTOR FACILITIES

Mr. LUEDECKE. Section 107(b), project 60–e–12, is a request for an increase in authorization for the alterations of the Shippingport reactor facilities from the authorized $5 million in the 1960 bill to a total of $9 million, to enable the Commission to go ahead with the increase of the core size to 150 megawatts, and to provide a heat dump to take care of the excess steam over and above the capabilities of the present generating facilities.

Representative HOLIFIELD. Are there any questions on this?

Representative VAN ZANDT. What is the cost to us now for a kilowatt of energy at the Shippingport plant?

Admiral RICKOVER. You realize, Mr. Van Zandt, that on a development project such as Shippingport, cost figures on power generation have little meaning. To give you a specific number, however, something like 70 or 75 mills is of the right order. But it is not a realistic figure because we are doing things with the Shippingport plant you

would never do in a plant built and devoted exclusively to the commercial generation of electric power.

Representative VAN ZANDT. That is the point I want to develop. In other words, this is a research and development plant.

Admiral RICKOVER. Yes, sir; this is a research and development project, and from this project we are obtaining by far the majority of knowledge being developed for all water reactor plants, both pressurized and boiling. This information is also of great value to other types of reactors.

Questions on the cost of the Shippingport project have largely stopped in the last year when those who used to complain bitterly about the cost of Shippingport are running into the same high levels of costs themselves. So now the only question left to them is the cost of a unit of electric power from Shippingport.

One thing we do at Shippingport not done for any of the other plants is that we put down our real costs; there are no hidden costs or subsidies of any kind. All other reactors being built or planned, in computing their costs, assume they are going to run at a load factor of 80 percent.

You see, when you try to find out the cost from any of the commercial reactors, you can never get the complete figures. But the cost figures on Shippingport are always available to you because the only money we have is the money you appropriate. So that ties it right down. But you cannot find out from anyone else what their true costs are.

Representative VAN ZANDT. What does it cost us to operate the Shippingport plant?

Admiral RICKOVER. It costs the Government about $2 million a year. I am not talking about the research and development. I am talking about what it costs the U.S. Government to run the plant.

Representative HOLIFIELD. Does that include fabrication of fuel?

Admiral RICKOVER. No, sir; that does not include research, development, or the fuel fabrication costs. The $2 million is an extra sum the Government puts in to carry out operational tests with the reactor plant. If we stopped all research and development today, $2 million is what it would cost the U.S. Government to get the necessary test data out of Shippingport.

Representative VAN ZANDT. Is the plant down at the present time?

Admiral RICKOVER. Yes, sir; the plant is down for refueling at the present time. In about 2 months we expect to have it back in operation.

Representative VAN ZANDT. What core is this?

Admiral RICKOVER. We are still on the first core. This first core consists of a seed and a blanket. The first seed contained about 75 kilograms of fully enriched U^{235} and the blanket has about 14 tons of natural uranium.

When we designed the plant, we estimated that the blanket of the first core would last for two seeds. We also estimated that the life of the first seed would be about 3,000 full-power hours. Actually, the seed ran for 5,800 full-power hours.

We are in the process of replacing this first seed with a second seed. The second seed will operate, we estimate, about 1,000 hours longer than the 5,800 hours of the first seed.

One of the most important factors in evaluating economics of nuclear power from reactors using natural or slightly enriched unanium is the expression known as "megawatt-days per ton." The Shippingport reactor has at present been subjected to a greater megawatt-days per ton burnup than any reactor in the world. I am talking about natural uranium. So all of the promises, all of the statements being made about the life of power reactors of any kind, are based largely on what we have proven so far at Shippingport.

This includes the British Calder Hall type reactors, too. The average megawatt-days per ton, until the present time, to which we have subjected the Shippingport natural uranium blanket, is about 1,990. That is average.

Representative HOLIFIELD. 1,990?

Admiral RICKOVER. Yes, sir; 1,990 megawatt-days per ton average. In a reactor, the maximum burnup is about four times the average. So you must be careful when you question people about megawatt-days per ton that you ask them, "Are you talking about the average or the maximum burnup?"

Representative HOLIFIELD. In other words, some of the rods last longer than others?

Admiral RICKOVER. Yes, sir; as you know, the megawatt-days per ton burnup depends on the neutron flux; the flux distribution is like that of a cosine curve. At the center there is a much higher burnup than there is at the ends or sides of the core.

The largest maximum burnup which has been obtained to date with natural uranium in any operating reactor in the world, has been at Shippingport. So, anyone who is quoting figures on costs and life must inevitably base his estimates on Shippingport results. The actual Shippingport burnup figures are 1,990 megawatt-days per ton average, with 8,770 megawatt-days per ton maximum.

Representative HOLIFIELD. Relate this to the guarantee which an American manufacturer gives to a foreign purchaser.

Admiral RICKOVER. The guarantees are all made on the basis of average figures. When a man comes around and tells you his reactor core will be subjected to 10,000 or so megawatt-days per ton, he is talking about average burnup figures, which means he is talking about figures which are about five times as great as we have achieved in the Shippingport reactor in its 2 years of operation. With the present core we would have to operate Shippingport for about 10 years to prove out in an actual power reactor this 10,000 megawatt-days per ton burnup.

Representative HOLIFIELD. These new reactors are going to be different from Shippingport, and, therefore, from a technological standpoint, do you feel that this is why the five-times-life guarantee can be given? Or do you feel that this is based more on speculation than it is based on analysis?

Admiral RICKOVER. I can only say this, Mr. Holifield: If I were a contractor, I would not guarantee any such reactor. The Government, because of its unlimited financial resources could. But as a contractor I would not, if I were running a business, guarantee 10,000 average megawatt days per ton.

I am certainly not father to all wisdom in this field. There are many people who have looked into this matter. But from experience

I have had I would not today guarantee 10,000-megawatt days per ton average, which means about 40,000-megawatt days per ton maximum. However, we have run tests in testing reactors where we have reached, on small samples, maximum burnups as high as 70,000-megawatt days per ton. At these values the uranium appears to have significant changes in its structure.

That is not the whole story, however, because where you generally have trouble is not only in the fuel itself, but in the cladding, the fuel element size, and in its shape. If, for example, you make the core with long fuel elements, radiation effects could cause them to bend or twist.

All these factors must be taken into consideration. Saturday I was in Idaho and I examined the blanket elements that recently came out of the Shippingport reactor. We did not have to take those out of the reactor. We took some of them out just to check them and see how they looked. They looked practically perfect. About 1 mil of scale has been deposited on these blanket fuel elements; there is no deformation of any kind. However, these fuel elements are only 10 inches long. They are assembled in bundles, as you may remember.

Representative HOLIFIELD. And they are the farthest from the core, too.

Admiral RICKOVER. No; we took out those that are in toward the center. That is to say, we took out the ones that had the highest burnup. We wanted to see what the hardest worked ones looked like. So we now have reasonable confidence that we can keep on operating the blanket with another seed, perhaps even a third seed, and we will get more megawatt days per ton burnup. We hope before we are through with the first blanket that we may get as much as 8,000 megawatt days/ton average burnup. Whether we will or not I cannot, of course, say at this time. Only through actual operation of the core can we know definitely.

Representative HOLIFIELD. That is the blanket?

Admiral RICKOVER. Yes, sir.

Representative HOLIFIELD. Not the seed?

Admiral RICKOVER. The seed is enriched uranium, sir. Megawatt days per ton is applicable to natural uranium, not to highly enriched uranium.

Representative HOLIFIELD. To slightly enriched?

Admiral RICKOVER. Slightly enriched also. Shippingport is the only place in the world today where you can get information of this type; information on which many other power reactors depend. That is the main reason for going on with the Shippingport project, sir.

In my opinion, the argument about the size of core and some of the other matters raised are absolutely irrelevant. If it were not for this reactor you would have to build one or two more large reactors to get the desired information.

We already have the capital facilities at Shippingport. So if we are going to use them we ought to use them as fast as possible to develop the technology.

Representative HOLIFIELD. You tell us that you have gone up from 50 megawatts to 100 megawatts.

Admiral RICKOVER. No, sir.

Representative HOLIFIELD. You have that capacity; do you not?

Admiral RICKOVER. The plant was designed for 60,000 megawatts electrical net output, which means about 67,000 to 68,000 gross, the other 7,000 to 8,000 being used to service the plant itself. We have generating capacity for 100,000 kilowatts.

Representative HOLIFIELD. With the old core?

Admiral RICKOVER. With the old core. We purposely installed a 100,000-kilowatt turbogenerator instead of a 60,000 one because we figured that some day we would get smart enough to design a core that would give us 100,000 kilowatts. So when we started designing the new core we initially aimed at 100,000-kilowatt output. But after proceeding a while it appeared we could obtain 150,000 kilowatts.

The Shippingport project is so important for developing basic reactor information I thought it wise to take this subject up with Mr. McCone, and he agreed, as did your committee, a year ago, that we should proceed on the basis of a 150,000-kilowatt core.

So the real issue now is how do we get the additional capacity to dissipate the energy in excess of 100,000 kilowatts. That is the real issue. The core which is presently installed was designed for 60,000 kilowatts. We installed generating capacity for 100,000 kilowatts, with the idea we would learn more as we went along to enable us to design a new core for 100,000 kilowatts.

Had we not been so good in design we would not be here today. Our trouble stems from the fact that we have done too well. That is why we are in difficulty.

Chairman ANDERSON. Why do you propose a heat sink instead of adding electric generating facilities?

Admiral RICKOVER. We did not propose a heat sink originally, Senator Anderson. Originally we proposed adding electrical generating capacity, not only an additional 50,000 kilowatts, but an additional 75,000 kilowatts, because we figured we might run into the same problem later on—that on the third core we could get even more than 150,000 kilowatts.

We wanted to be prepared for future improvements. In view of the stringency of Government funds and for other reasons, such as the problems connected with an intrastate utility and a number of other technical and legal problems, the Commission decided, and I agreed with them, that we should approach the Duquesne Light Co. to see whether they would supply the additional 75,000-kilowatt generating capacity at their expense.

You must realize that of all reactor contractors working with the AEC, Duquesne has been a most generous financial contributor. They have already put in $20 million of their own money on generating facilities. In addition, they are paying for about 100 of the employees who are manning the Shippingport station.

Furthermore, they contributed about $5 million toward the development and construction of the plant itself. I believe these are pretty good indications of generous interest by a private utility company.

From their standpoint—they are, as you know, an intrastate utility with no customers outside the State of Pennsylvania—they have done an outstanding job in cooperating with the Government.

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When we ask them to put in an additional $23 million or so, that is another matter. You can understand the natural reluctance of an intrastate utility such as Duquesne to spend that much more money. So when the Commission asked me to develop this problem with Duquesne, I went to Mr. Fleger, the chairman of their board. He came up with the figure of about $23 million for the cost of an additional 75,000-kilowatt gross generating capacity. Of this $23 million, $5 million was for additional transmission facilities.

Representatve HOLIFIELD. How much was that figure?

Admiral RICKOVER. $5 million for the transmission facilities, which would have to go in to be able to transmit the electricity to the city of Pittsburgh. Their plans at the present time do not include generating additional electricity from the Shippingport direction.

Representative HOLIFIELD. The existing lines could not carry it?

Admiral RICKOVER. That is correct; and they figured that this $5 million cost for transmission line expansion was a proper charge to make.

They estimated $18 million for the additional cost of the generating plant. Their proposal amounted essentially to this: They would supply the sum of $23 million, and they wanted a contract to last 10 to 15 years so they would amortize the $23 million. Their proposal, essentially, amounted to the Government paying 6 percent interest annually on $23 million.

This was the real substance of the Duquesne proposal. In addition to that, they asked for guarantees from the Government on reactor output and on total yearly power generation. If we did not meet these guarantees requested by Duquesne, we would be obligated to make them up financially.

Shippingport being a research and development plant, we obviously could not go along with such a proposal. So the Commission appointed an AEC Board to look into the matter. The Board recommended against its acceptance. Mr. McCone then requested that I go back to Mr. Fleger to see if I could get better terms.

Duquesne stated they could not give us any better terms in view of the large sum of money they had already invested. Then it was decided to go back to Duquesne and ask if they would, at their expense, put up a heat sink, similar to a condenser. They said they would do this, and that it would cost approximately $4 million. They could be willing to put up the $4 million, and to charge approximately 6 percent interest, but the Government would not have to make any performance guarantees of any kind.

Furthermore, at the end of a 5-year period, which they were going to use to amortize this heat sink, the heat sink would belong to the Government. I think this was an eminently reasonable proposal. But from the standpoint of the Government, after the Commission looked into it, it appeared that it would be cheaper for the Government to put the heat sink up itself. This is where this matter stands now.

Senator GORE. Mr. Chairman——

Representative HOLIFIELD. Mr. Gore?

NUCLEAR SUBMARINE

Senator GORE. Admiral, this is not directly on the point of your testimony just now, but it is certainly a related matter. While all the attention has been focused on the missile gap, I have been equally concerned with the submarine threat. From the state of reactor development which Congressman Holifield and Congressman Van Zandt witnessed in the Soviet Union several months ago, from the launching of the icebreaker, I have been concerned that perhaps they had the capacity for a nuclear submarine, with the multiplication of their submarine threat and possible development of missile capability from submarines.

I wanted to ask you if you share my view or if you can discuss it in open session, if you obtained any information while you were there, which led you to believe, as I have been led to believe, that the Soviets perhaps have such capability?

I do not want to be specific in my questions, because I do not want to be in the position of eliciting any classified information. But if you have any observations on this line, I would be pleased to receive them.

Admiral RICKOVER. Senator Gore, I cannot, of course, go into detail, as you yourself recognize, on specific questions about our missile or submarine strength in an open meeting.

Senator GORE. I have not asked specific questions.

Admiral RICKOVER. I understand, sir. I can tell you this, and this has been testified to before by myself and by other Navy witnesses: That the Russians are estimated to have about 450 submarines at the present time, the majority of them being oceangoing submarines; that they have the capacity to construct about 100 submarines a year.

There is no question in my mind, or, I am sure, in the mind of anyone who is knowledgable in this field, that they are making strenuous attempts to develop a nuclear submarine capability. I understand when Mr. Khrushchev visited Camp David he was quite interested in seeing the motion pictures of our nuclear submarines breaking through the ice.

As you know, another of our nuclear submarines, the *Sargo*, punched through the ice at the North Pole just a few days ago. If the Russians wished, they could in 5 years or so have more nuclear-powered submarines than we have, if they make up their minds to build them on a priority basis.

Senator GORE. Would you say that again?

Admiral RICKOVER. I said in 5 years or so——

Senator GORE. Mr. Chairman, I cannot hear the witness.

Admiral RICKOVER. It is my opinion, and I am not necessarily reflecting the views of the Defense Establishment, that in about 5 years they can have more nuclear submarines operating than we.

In my opinion, we are frittering away a lead in perhaps the only weapons system in which we are ahead. We are not taking advantage of our lead by building enough nuclear submarines at the present time. That is my personal opinion.

Representative VAN ZANDT. Will the gentleman yield?

Senator GORE. Yes.

Representative VAN ZANDT. I take it, Admiral, you are in support of my bill for building 100 additional attack nuclear-powered submarines?

Admiral RICKOVER. I would support it heartily, sir.

Senator AIKEN. When you say in 5 years or so they can have more nuclear submarines than we will have, does that not depend on the degree of effort they put into building them and the degree of effort we put into building them?

Admiral RICKOVER. Yes, sir.

Senator AIKEN. What is the comparative potential for building them, assuming we dropped everything else and just built nuclear submarines?

Admiral RICKOVER. Senator Aiken, there is no question about the potential, because it has been stated frequently by military people who have testified to committees of Congress that they have the capacity to build about 100 submarines a year.

Senator AIKEN. And it would depend to what degree they are willing to sacrifice other activities; would it not?

Admiral RICKOVER. Yes, sir.

Senator AIKEN. There is a difference between what they could build and what they may build, and that goes for us, too.

Admiral RICKOVER. Yes, but the sacrifice here, I am sure, would not be anywhere near as great, because their standard of living is about one-third of ours. However, in their military sector, they do not use less manpower than we do.

Senator AIKEN. How does our capacity to build compare with theirs?

Admiral RICKOVER. We do not have the capacity to build as many as they, but we do have the capacity to build many more than we are building now. Mr. Van Zandt discussed that with me the other day.

I believe that we could easily build 10 additional attack submarines a year. We have the submarine building facilities as well as the manufacturing capacity for the nuclear and machinery components.

May I repeat what I told you, sir?

Representative VAN ZANDT. Yes.

Admiral RICKOVER. I told Mr. Van Zandt that we now have three sources of supply for buying the complete equipment, on a competitive lump-sum basis, for 10 more nuclear attack submarines a year.

Senator AIKEN. Could we reach a point where it would not be practical to go beyond that? When you get enough submarines, would you continue to build more, or would Russia do the same?

Admiral RICKOVER. Senator Aiken, we surely have not reached that point yet.

Senator AIKEN. I agree with you on that.

Admiral RICKOVER. I think we could safely build 10 more a year for several years. By that time—of course, we might have peace, we might both turn all our swords into plowshares—isn't that the expression?

Senator AIKEN. I see.

Chairman ANDERSON. What we have thus far agreed upon is that Vice Admiral Rickover agrees with Captain Van Zandt that the Navy should go ahead?

Admiral RICKOVER. If you put it in those terms, sir, you should say Captain Van Zandt agrees with Vice Admiral Rickover. If you say Admiral Rickover and Congressman Van Zandt, that is another thing.

Chairman ANDERSON. I reverse the order.

Senator GORE. Mr. Chairman, if we are going to have protocol here, I insist I yielded only for a question.

Chairman ANDERSON. I never served in the Navy, so I am happy to have my proper classification and order of preference straightened out.

Senator GORE. Mr. Chairman, I would like to ask one more question of the admiral.

Coming as it does from a layman, do you share the concern I have felt that a fleet of several hundred submarines with missile capability might pose a threat at least equal to the threat of ICBM's?

Admiral RICKOVER. I believe that at the present time the ballistic missile launching submarine is the best deterrent we have. As a matter of interest, I just came back this morning from the trials of our second Polaris submarine, the *Patrick Henry*.

Since what we are really discussing is our freedom, that is a pretty good name for the ship. Her trials were successful. Before the end of the year the Navy expects to have the *George Washington*, the first Polaris submarine, and the *Patrick Henry*, on station.

I do not think it would be at all necessary to have hundreds of Polaris submarines, because each of these submarines has 16 missile tubes. I understand that in consequence of Senator Anderson's request, the entire committee will have the opportunity to visit the *George Washington*, going to sea in her, over the weekend of the 9th and 10th of April. So you will see for yourselves the tremendous deterrent each Polaris submarine constitutes.

I do not believe hundreds are necessary. Only nine are authorized at the present time, with three additional requested in fiscal 1961. I understand the Navy may ask for an additional number, three or more, for fiscal 1961.

Senator GORE. You have said that in your view the submarines with ballistic capability were our best counterthreat. I ask you about the threat to our own shores.

Admiral RICKOVER. From such weapons?

Senator GORE. From such weapons in the hands of a potential enemy.

Admiral RICKOVER. That definitely is the case, sir. The Russians, according to information which has been made public, have submarines which can fire missiles a minimum of 200 miles, perhaps as great as 800 miles.

With a missile range such as that, their submarines could easily destroy about 70 percent of our manufacturing capacity, because it is mostly concentrated along our coasts. That threat definitely exists. The reason that Captain—and I hope he soon makes admiral—Van Zandt was interested in asking for additional attack submarines, 10 a year, was to try to counter that threat, because the best way to combat an enemy submarine, particularly a nuclear submarine, is by our own nuclear submarines.

That was the basis for Mr. Van Zandt's desire to build 10 more attack submarines a year, above and beyond the number currently being requested.

Does that answer your question, sir?

Senator GORE. Well, I think you intended to, but I wanted you to be a little more specific, if you could, by way of comparison.

With the present state of ballistic missiles in stockpiles, insofar as we know it, do you regard the potential threat from submarines with ballistic capability as great to the United States as the ICBM threat may be?

Admiral RICKOVER. Again, talking for myself, Senator Gore, I think it is even greater, because at the present time, due to the existing imperfections in missiles, and, of course, this will be rectified, the missile with a shorter range is easier to fire and certainly would be more accurate than one with a greater range.

It is an easier job to fire a short-range missile than it is a long-range missile. This is where the use of the submarine comes in. Assuming, for example, the Russians had 100 submarines lying off the east coast; they could fire missiles, say, at the 200- or 300-mile range. There is certainly more of a chance of hitting a target at a short range than there is at a long range. The missiles are not as large and the problems not as great.

Senator GORE. Thank you.

Representative HOSMER. I have just one question along this line, Admiral Rickover.

Would you judge in general that possessing a well-rounded nuclear submarine fleet would be of greater value to the U.S.S.R. or the United States?

Admiral RICKOVER. It would be of greater value to the U.S.S.R. than to the United States for the simple reason that it is almost inconceivable the people of this country would initiate a war.

Representative HOSMER. I am thinking from the standpoint of deterrence, and so forth, the general objectives of the country.

Admiral RICKOVER. From a physical standpoint, they would be better off because their industry and their population are not as concentrated as ours. In fact, for several years they have been deliberately planning, and they are succeeding in decentralizing both their industrial and their scientific and development facilities.

We have talked a great deal about doing the same but we have not done anything so far. I doubt, with our national optimism, we will do anything about it.

Representative HOSMER. I included in my question a well-rounded fleet, and that would bring up our attack submarines to counter their missile submarines.

Admiral RICKOVER. I tried to summarize my answer to your question, sir. I think they would always have some advantage from the fact that they would not be as vulnerable because of the dispersion of their warmaking potential.

The other point is the one of national intention. I do not believe the national intention of the United States to go to war with another country would be anywhere near as great as for another country to go to war with us.

Representative HOSMER. Let us put it down this way, then: Is a nuclear submarine fleet of greater or lesser defensive value to us than a submarine fleet is of offensive value to the U.S.S.R.?

Admiral RICKOVER. I believe the offensive always has the advantage, sir.

Representative HOSMER. Thank you.

Chairman ANDERSON. Mr. Chairman——

Representative HOLIFIELD. Senator Anderson?

Chairman ANDERSON. A moment ago, the way you said that the Joint Committee on Atomic Energy was going on the *George Washington*, left some doubt as to whether the Vice Admiral was going along on the *George Washington*.

I wondered if it might be necessary to have Captain, soon to be Admiral, Van Zandt invite you to go, or whether the committee could now invite you to come along with us, because you have been with us on the other two trips and we would not want you absent on this one.

Admiral RICKOVER. If you ask me, sir——

Chairman ANDERSON. I will transmit it through the Captain.

Representative WESTLAND. If the gentleman will yield, I would suggest that we have another captain here, Capt. Craig Hosmer.

Chairman ANDERSON. A Navy captain?

Representative HOSMER. Yes.

Chairman ANDERSON. I beg your pardon.

Admiral RICKOVER. You will note that the Navy people are all on this side, sir.

Representative WESTLAND. And we also have Commander Bates.

Representative HOSMER. And Commander Westland.

Representative HOLIFIELD. It looks like a stacked deck to me.

Chairman ANDERSON. In behalf of the common people, Admiral, I invite you to come along.

Mr. McCone, I have to be on the floor, and I have one question.

FUNDS FOR PROJECT ROVER

There appeared in the Wall Street Journal this morning an editorial entitled "Not Everything at Once." This will be out of order, but the chairman said I could. It says:

> **The critics of big government spending ought not overlook the manner in which the Atomic Energy Commission has got hold of the money it says it needs for the development of a nuclear-powered rocket. The whole set of circumstances showed that sometimes a battle is won by those who believe that Government spending does not always have to be as big as its sponsors say.**

It goes on to point out that Mr. Maurice Stans, Director of the Budget, had trimmed down things to where there was not quite enough money for project Rover and that you, spurred on by the head of the Joint Committee on Atomic Energy, went to work on the Budget Bureau.

I have publicly expressed my deep appreciation for the fact that you have gone ahead, but I think these questions this morning which relate to different types of defensive devices indicate that we need not only submarines but need atomic propulsion for vehicles.

I wonder if you would comment on this article a little bit. It leaves the impression that the AEC budget is one that can be reduced and shrunk several million dollars whenever anybody requires it. It was my impression that this represented some real sacrifices on the part of AEC, and a real, sincere effort on the part of AEC to try to meet a national situation. I thought I would like to have your comments, if I might, on the record, for this meeting.

Mr. McCone. Yes. If you will recall, Senator Anderson, our original request for money was reduced by about $13 million, as I remember.

Chairman Anderson. That was for project Rover.

Mr. McCone. Yes. It was reduced by the Bureau of the Budget after consultation with NASA, the using agency, because the schedule for progress on Rover appeared to NASA to be out of phase with the then schedule of the Saturn project, and Rover was to be an upper stage of Saturn.

They argued that the project could be decelerated somewhat and brought along more in consonance with Saturn. Later the President authorized $125 million, or $135 million additional money, for NASA which, among other things, accelerated the Saturn project.

I went to the Bureau of the Budget and asked for a restoration of the funds on the ground that there was a new phasing and we had to proceed with Rover in keeping with the new Saturn program; therefore, we wanted to reestablish the original program which we had requested.

The Bureau of the Budget came back and said that they were sympathetic with that, they would approve the authorization, but they asked if we could find the money by reapportioning money from other sources. I told this committee in two hearings, I believe, of that decision, and said that I felt it was my obligation and our obligation to see whether we did have funds from some sources, from reserves, or from projects which we were carrying forward at a little less cost than our estimate.

I thought that was the first thing to do. If we could not find the money, we would then go to the Bureau of the Budget. We found money from several sources.

In the first place, the Euratom research and development program had not taken the money that was appropriated by several million dollars, and, therefore, we moved $3 million from that project over to the operating cost for Project Rover.

In 1958 and 1959 we had authorization and appropriations for miscellaneous development work and added projects for the Eniwetok Proving Grounds that we could take $4.4 million for transfer to Project Rover.

There was a similar situation at the National Reactor Testing Station for electrical distribution. It appears that the scope of our work has changed somewhat and there is a saving of $1.7 million. We moved that, too.

There was also the Tonopah Test Range project, a proposed 1961 project, which we, upon study, decided we would not have to proceed with, and that provided $1.9 million.

In total, from those projects, we recovered the $8 million that was needed for the construction work in Nevada, and from the Euratom program we gathered up the $3 million for operations. That established the level of funding at $21 million.

I think it is not unusual in a budget of $23/4 billion for a current year and for a prior year to be able to, by a little careful screening of what you are doing, find money in this order. We regularly do it. If at the end of the fiscal year the year's available funds are not obligated, the unobligated amount is reported and carried over and applied against requirements for the next year.

Representative HOLIFIELD. As a matter of fact, in this bill we have close to $20 million rescission of projects that have been either modified or annulled.

Mr. MCCONE. That is right. After all, you are running $7 billion worth of facilities and 110,000 men, and there are bound to be changes that come up day to day and week to week.

That is the way this money was found. I do not feel that this should be construed as a fact that money is being hoarded or not properly handled. I think this was an orderly thing to do.

Chairman ANDERSON. I not only agree with you, but I certainly commend the Atomic Energy Commission for the way it went about it. Naturally, if we had resumed testing, your budget being made out last fall, if we had resumed testing October 31 or January 1, the validity of some of these projects at Eniwetok, Tonopah, and others would have been very well established.

If the European nations, instead of coming in with just the Senn reactor, had come in with four or five reactors, under the Euratom project, you would have needed the money in the budget.

Mr. MCCONE. And probably more.

Chairman ANDERSON. The fact that they did not come in does not indicate that the AEC was loose in the way of its budgeting or that this committee had been too liberal in the way it has authorized funds.

I was sort of distressed to read the editorial, because it is my impression that the Atomic Energy Commission had been extremely careful. I commended it then and I commend it now for trying to put the money where it does the most good.

I will call your attention, Mr. Chairman, to the fact that there is a project known as Project Orion, which has been classified and declassified. Somebody declassified it. There is a letter from the Department of Defense under date of February 24 enclosing a declassified letter, speaking of the fact that Defense undertook a feasibility study on the possible use of nuclear detonations to propel space vehicles.

As I tried to point out one day, the original work on this was done by Dr. Stan Ulam, whose name appears on the patent for the atomic bomb.

The Atomic Energy Commission tried to get additional money for this work, but could not do it. I notice in a prerun of Nucleonics Week, No. 5, dated March 10, it says:

The orphan Project Orion landed on the Air Force's doorstep. The 2-year-old program of General Atomics to propel space platforms by controlled nuclear explosions was transferred back from the AEC to Defense Department's Advance

Research Projects Agency after the National Aeronautics and Space Administration balked at GA's $90,000 a month tab.

You folks got turned down for any money for the period of scientific work, and somebody else picks up $40 million a year to carry it on. I think after that it is a harsh thing to say that the Atomic Energy Commission might have been loose in finding $3 million or $4 million to work out what many of us find to be an attractive proposal.

Mr. McCone. As you know, the Commission is enthusiastic in its support of the Rover project. We think it is one of the very promising projects we have underway.

Chairman Anderson. I know it is. I say again, if it is delayed, it has been delayed by the work of another agency and not the Atomic Energy Commission.

Again, in open session, I want to commend the chairman, the members of the Commission and their officials, for working as well as you have to see that adequate funds are ready for Rover. This promises to be an extremely fine development. I am glad you stuck by your guns.

Representative Holifield. If the members will bear with the Chair, we are going to try to finish up with this particular item just as soon as we can so we will not have to call the witnesses back this afternoon, and so that some of the Members of the House can answer a quorum call which we anticipate in a few minutes.

First, however, I will yield to Mr. Hosmer for one or two questions. Then we will get back to the projects.

ALTERATIONS TO SHIPPINGPORT REACTOR FACILITIES

Representative Hosmer. The ad hoc advisory committee report of February 15, in its summary, after stating that the core 2 represents significant improvements and advances and should yield substantially valuable results, says—

We have been assured that planning and developmental work on core 2 with a rating of 150 megawatts has already proceeded so far as to render moot the question of undertaking core 2 with a somewhat lower rate. We feel bound to say, however, that the review the committee was able to make did not convince them that the increased costs were warranted by the technical advantages of a rating above 100 megawats for which generating equipment is already installed.

That subjects both you and Mr. McCone, Admiral Rickover, to criticism, and I think the committee, itself. I would like to have something on the record that will at least give us somewhat of a skirt-cleaning job.

Admiral Rickover. I really must hold myself back to answer this question, because in my experience I have never found a committee that could do a job. You know the old expression that a committee cannot paint a picture, and that is exactly the situation you have here.

You will also find that this committee recommended still another committee, and I am sure that that committee will recommend still another committee, because we certainly want do not want to put committees out of business.

Representative Holifield. You are not talking about congressional committees now.

Admiral Rickover. No; you asked me that question once before.

Representative HOLIFIELD. I just want to keep the record straight

Admiral RICKOVER. Your authority derives from the Constitution. The other committees derive their authority from Government expenditures. There is quite a difference. So there is no comparison. You are performing a legal function which, of course, you should, and we could not have our form of government if you did not.

But I do not see how people who have not been immersed in highly technical problems, such as this, spend a short time on a problem and make valid technical decisions.

Today these technical matters are highly complex. They involve thousands of hours of computing-machine time, the work of thousands of scientists and engineers. No man can sit down and look at a reactor design and arbitrarily say, "This is what we ought to do." We have never found that to be the case.

Representative HOSMER. You can say categorically that the benefits to be gained from running this above 100 megawatts are worth the expense?

Admiral RICKOVER. Absolutely, sir. I think if you did not do it this way, you would be obliged to build a completely new large reactor. All of us are interested in saving money and in using the talent we have as economically as possible.

I will make another categorical statement: I think today if you wanted to be wise in spending money, you would pick out the successful development groups in any field, whether they are in rockets, missiles, reactors, and you would load them up as much as they permitted you to load them. No man who is really dedicated to his project will undertake developments he does not believe in.

The surest way to have a successful project is to let a man who believes in it work his head off doing it. That is the only way you can do it. You are people who are involved in the field of politics, and you know from your political sense that you can only get things done by and through people, by judging who are the right people. That is all you can do: there is no other way.

Representative HOSMER. Thank you, Admiral.

I was going to ask if you were going to appoint the second committee, but I will not do it now, Mr. McCone.

Mr. MCCONE. I would like to comment on that particular paragraph in the report because it was given serious consideration by the Commission in a formal meeting.

We concluded that there were reasons quite beyond the considerations of this Advisory Committee which would prompt us to pursue the development of core No. 2 at 150 megawatts. This was not made lightly. It was seriously considered.

There were some of the technical questions in core design and power density that could be proven, to be sure, with a 100-megawatt core. But all of the things we sought, including the demonstration of the capacity of the plant as a whole, could only be done if the core were brought up to 150 megawatts. For that reason, we disagreed with our Advisory Committee and, incidentally, we disagree with our Advisory Committee quite often.

Sometimes the Commission has to consider responsibilities quite beyond the terms of reference of the particular committee.

Representative HOLIFIELD. I do not think you have to have any fear at all that this committee is not completely behind bringing this up to

150 megawatts and getting some operational experience at that for the period of time that it is necessary to develop the statistics that we need on fuel elements and other factors that are involved.

I would like to address myself, if I might, to the question of furnishing this additional capacity.

What was the deciding factor on their part against this? Was it the interruptibility of service or was it the 8-mills per kilowatt-hour that we were charging them?

Admiral RICKOVER. No; the idea was that this was an additional large investment on Duquesne's part and they felt that they had already made the most significant financial investment of any utility company in the nuclear field. They did not feel it was incumbent on them to provide more money to improve the art.

They were quite willing to put up the facilities and charge the Government a 6-percent interest rate, plus getting governmental guarantees of uninterrupted service. This uninterrupted service is not compatible with the research and development we are trying to do at Shippingport.

Representative HOLIFIELD. I understand. That is why I wondered if this was a primary factor in their consideration. If they do need additional kilowatts in their system, and if they have to build conventional plants to obtain those kilowatts, and if we could furnish additional kilowatts from this plant at an attractive price to them, I wonder if that was explored.

Admiral RICKOVER. Yes, sir.

Representative HOLIFIELD. In other words, even a reduction in price of the kilowatts?

Admiral RICKOVER. Yes; it was explored. The basic reason, as I understand it, is that as far as Duquesne is concerned, Shippingport is a standby plant. Duquesne has about 1,200,000 kilowatts of installed capacity. What they get out of the Shippingport plant is a small part of the total.

Representative HOLIFIELD. So the investment of $23 million for an interruptible supply from their standpoint would not be economic, particularly in the view that it is interruptible?

Admiral RICKOVER. That is correct, sir.

Representative HOLIFIELD. Would the heat sink arrangement which is going to cost—is it $9 million?

Admiral RICKOVER. $4 million or a little less, sir.

Representative HOLIFIELD. Will that give you the same ability to obtain operational data on your reactor as if it were attached?

Admiral RICKOVER. Yes, sir. It will be completely equivalent. In fact, it will be even better because we will not be tied into an outside demand for power. We can just use the heat sink as we wish. There is no reduction in our ability to obtain data. In fact, it will be enhanced.

Representative HOLIFIELD. Because you can interrupt it at will and have no obligation at all for furnishing in-line power?

Admiral RICKOVER. That is correct, sir.

NATURAL CIRCULATION TEST PLANT

Senator DWORSHAK. Could I ask a brief question?

Last year we gave you $18.5 million for the natural circulation plant. What progress has been made in that?

Admiral RICKOVER. We expect to start construction at Idaho by the end of this fiscal year.

Senator DWORSHAK. Who is going to do the work?

Admiral RICKOVER. We do not know that yet, sir. Of course, our contract is with the General Electric Co. But it is our intention, as Mr. McCone has told you previously, to locate it in Idaho.

Senator DWORSHAK. There is no possibility that it will be sent to some eastern plant because GE has the contract?

Admiral RICKOVER. No, sir.

Senator DWORSHAK. You are determined to do the work as the Congress originally directed that it be done?

Admiral RICKOVER. Yes, sir. You have that assurance from the Chairman of the Commission.

Senator DWORSHAK. Thank you.

MODIFICATION TO NAVAL PROTOTYPE PLANT

Representative HOLIFIELD. I wanted to ask you about one item which I noticed was asked for, "Reactor modification to enable the prototype plant," for $5.6 million. This was denied by the Bureau of the Budget.

The item is for reactor modification to naval prototype plants, $5.6 million. Are you acquainted with that?

Mr. LUEDECKE. Yes, sir. This item was not submitted to the Bureau as a construction project; it was included in our estimates for the "Operating expenses" appropriation in the amount of costs anticipated in fiscal year 1961.

Admiral RICKOVER. Yes; that is not any problem for us.

ALTERATIONS TO SHIPPINGPORT REACTOR FACILITIES

May I say one more thing about the Shippingport reactor? I hope we get authority or at least an understanding that the committee looks favorably or unfavorably on it because we have to go ahead with architect engineering. We have certain funds which we could legally use to get started.

Representative HOLIFIELD. I think I would be out of place to make any kind of a firm commitment, but I believe I can express the general feeling of the committee that they want you to go ahead with this operation at Shippingport, which would indicate approval of this by the committee. That will have to be taken into consideration by the committee as a whole.

Admiral RICKOVER. Yes, sir; I understand that thoroughly.

Representative HOLIFIELD. The authorization bill, I might say, should be out by about mid-April. We have 2 more days of hearing, and in the early part of April we will wait for some reports. As soon as those reports come in, we should get it out. It will be considered on the floor shortly thereafter, and then, of course, it will go to the Appropriations Committee.

Admiral RICKOVER. Thank you, sir.

Representative HOLIFIELD. Before we adjourn, I will announce that there will be an executive session of the committee in F–88 today, and then there will be an open meeting in this same room tomorrow morning at 10 o'clock.

Thank you.

(Whereupon, at 12:10 p.m., Thursday, March 10, 1960, the subcommittee recessed, to reconvene at 10 a.m. Friday, March 11, 1960.)

AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1961

FRIDAY, MARCH 11, 1960

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON LEGISLATION,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m., in room F–39, the Capitol, Hon. Chet Holifield (chairman of the subcommittee) presiding.

Present: Senators Anderson and Jackson; Representatives Durham, Holifield, Van Zandt, Hosmer, Bates, and Westland.

Also present: James T. Ramey, executive director; David R. Toll, staff counsel; Edward J. Bauser, technical adviser; and Bernard V. Dvoskin, GAO consultant.

Representative HOLIFIELD. The subcommittee will be in order.

The Subcommittee on Legislation is meeting this morning to continue hearings on S. 3084 and H.R. 10656, bills to authorize the appropriation for the Atomic Energy Commission for fiscal year 1961.

POWER REACTORS AT REMOTE MILITARY INSTALLATIONS

This morning we are scheduled to receive testimony from Army, Navy, and AEC representatives concerning power reactors at remote military installations.

I would like to insert into the record at this point a copy of the letter dated March 8, 1960, to me from my colleague, Senator Henry M. Jackson, concerning his visit to our bases in the Antarctic; also copies of letters dated March 9, 1960, from Congressman Melvin Price and me to the Secretaries of the Navy and Army concerning plans for the hearing this morning.

(The letters referred to follow:)

U. S. SENATE,
COMMITTEE ON ARMED SERVICES,
March 8, 1960.

Hon. CHET HOLIFIELD,
Chairman, Legislation Subcommittee,
Joint Committee on Atomic Energy,
U.S. Capitol, Washington, D.C.

DEAR CHET: As you know, I visited the Antarctic during the last recess. My visit impressed upon me the great value of nuclear reactors for energy generation at our bases in the Antarctic.

I strongly recommend that your legislation subcommittee take steps to assure that authorization for nuclear reactor plants at our Antarctic bases be included in the Atomic Energy Commission's next authorization bill.

I think it is very important to proceed with such a project without delay. I believe we should consider suggesting to the ARC and the Navy that design work and procurement be initiated prior to the normal legislative process for the forth-

coming year in order that advantage may be taken of the next construction season in the Antarctic, which starts in December.

During my visit I witnessed the logistic supply operation at our Antarctic bases first hand. Due to the extremely difficult and hazardous transportation conditions, the delivered cost of fuel oil is from $1 to $3 per gallon at McMurdo sound station, and between $7 and $10 per gallon at the South Pole station and Byrd station. To deliver 1,000 gallons of fuel from McMurdo to our South Pole and Byrd stations, each about 800 miles away by air, requires 4,500 gallons of airplane fuel. More than 70 percent of available cargo space on ships providing logistical support for our Antarctic stations is taken up by fuel.

Considering the high cost of conventional fuels in the Antarctic, it appears that a significant economic advantage exists for the use of nuclear reactors at our bases in the Antarctic. In fact, savings of many dollars per year will probably be incurred if reactors are used to supply our energy requirements in the Antarctic. Estimates now available to the Joint Committee indicate that over the 20-year life expectancy of nuclear reactors their use in the Antarctic would cut the cost of energy requirements there to as low as one-quarter the present cost of conventional powerplants.

In addition to monetary savings such projects would contribute directly to the development of our knowledge in the atomic power field in general.

A third advantage I see in proceeding with such projects concerns our international prestige. As you know we are engaged in scientific programs with 12 other nations in the Antarctic. The adoption of nuclear energy to further our scientific efforts and to ease the physical discomforts of our people living in the Antarctic I'm sure will greatly increase our international prestige.

Please feel free to call on me any time you think I can be of help in getting this important work underway.

Sincerely yours,

(S) Scoop,
HENRY M. JACKSON,
U.S. Senator.

JOINT COMMITTEE ON ATOMIC ENERGY,
CONGRESS OF THE UNITED STATES,
March 9, 1960.

Hon. WILLIAM BIRRELL FRANKE,
Secretary of the Navy,
Washington, D.C.

DEAR MR. SECRETARY: During Atomic Energy Commission authorization hearings yesterday before the Subcommittee on Legislation of the Joint Committee on Atomic Energy the Commission was asked to testify concerning the application of nuclear reactors to meet energy requirements on Guam and at our bases in the Antarctic. Preliminary information was received on a study which the Commission is performing for the Joint Committee which indicates advantages in the use of nuclear power reactors at these sites.

We would like to receive information on the plans of the Navy for use of nuclear reactors at its remote bases. Accordingly, it is requested that a representative of the Navy testify before the Legislative Subcommittee at 10 a.m., on March 11, 1960, to supply us with this information.

We were informed that until recently the Navy and AEC planned to substitute a nuclear powerplant for the conventional plant authorized for Guam in the 1960 Navy authorization bill. We understand that the Navy has not as yet started the construction of this conventional powerplant at Guam. We request that plans for construction be deferred on this project until we consider the report on the Atomic Energy Commission's study of reactor applications at such remote sites. The report is scheduled to be submitted to the Joint Committee by April 1, 1960 and hearings are planned for April 5–7.

We are also asking the Army to testify during the same session concerning their plans for use of nuclear power reactors on Okinawa and other remote Army sites. The hearing is to be open to the public and is scheduled to be held in room F–39 of the Capitol.

Sincerely yours,

CHET HOLIFIELD,
Chairman, Subcommittee on Legislation.
MELVIN PRICE,
Chairman, Subcommittee on Research and Development.

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
March 9, 1960.

Hon. WILBER M. BRUCKER,
Secretary of the Army,
Washington, D.C.

DEAR MR. SECRETARY: During testimony yesterday before the Legislative Subcommittee of the Joint Committee on Atomic Energy the Atomic Energy Commission provided preliminary information on its study of the use of nuclear reactors at remote sites. The information provided indicates possible significant advantages in such applications.

We would like to obtain information on the plans of the Army for use of nuclear power reactors at Okinawa and other remote bases. Accordingly, it is requested that a representative of the Army appear before the Legislation Subcommittee of the Joint Committee on Atomic Energy at 10 a.m. on March 11, 1960, to testify on the Army's plans for the use of nuclear reactors on Okinawa and other remote sites.

We have also asked the Navy to appear during the same session to testify on its plans for use of reactors at remote naval bases. The hearing is to be open to the public and is scheduled for room F–39, of the Capitol.

Sincerely yours,

CHET HOLIFIELD,
Chairman, Subcommittee on Legislation.
MELVIN PRICE,
Chairman, Subcommittee on Research and Development.

Representative HOLIFIELD. We will ask the Army witnesses to come forward at this time: Maj. Gen. L. E. Seeman, Director of Installations, Office of the Deputy Chief of Staff, Logistics; and Mr. W. B. Taylor, Office of the Chief of Engineers.

Please come forward.

General, I think you know from our letters of the interest of this committee in the possible installation of atomic reactors at remote installations.

STATEMENTS OF MAJ. GEN. L. E. SEEMAN, U.S. ARMY, DIRECTOR OF INSTALLATIONS, OFFICE OF THE DEPUTY CHIEF OF STAFF, LOGISTICS; COL. DONALD G. WILLIAMS, CORPS OF ENGINEERS, U.S. ARMY; COL. LEWIS D. VIEMAN, GENERAL STAFF, U.S. ARMY; CAPT. ARTHUR J. GOW, CORPS OF ENGINEERS, U.S. ARMY; W. B. TAYLOR, OFFICE OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY

General SEEMAN. Yes, sir. I have a short statement in reply to your letter and then I will try to answer any questions that you and the committee might have.

Representative HOLIFIELD. All right.

General SEEMAN. Sir, you asked for the Army's plans for the use of nuclear power reactors at Okinawa and other remote bases. As you know, the Army has participated with the Atomic Energy Commission since 1952 in developing a family of nuclear powerplants to furnish ground base power to meet the needs of the three military services.

We have continually reviewed our power and heat requirements to determine those for which reactors would provide us with a measurable advantage. We foresee requirements through 1968 which could be met by a considerable number of Army nuclear plants ranging in

size from a few hundred kilowatts mounted on wheels to approximately 40,000 kilowatts.

As you know, we have two small plants under construction to begin operation late in 1960, the Fort Greeley plant in Alaska and another at a remote Arctic site. We have provided information to the Commission for use in their recent study for you on the use of reactors for remote military installations for which new requirements are foreseen through 1970 in the 5,000-kilowatt to 40,000-kilowatt power range.

Note that this range is the upper end of the range of power capacity of interest to the Army. The Army applications suggested for study by the AEC in order of economic merit were first on Okinawa in the order of 40,000 kilowatts; second, for Nike-Zeus sites in the order of 10,000 kilowatts; third, for Inchon, Korea, in the order of 10,000 kilowatts, a floating plant; fourth, Asmara, Eritrea, in the 5,000-kilowatt range.

The Army's analysis of these sites considered additional military factors of flexibility for continued military use and strategic need of the particular location to be free from other fuel requirements. This analysis results in the following order of interest: First, the floating plant at Korea; second, the Asmara site; third, Okinawa; and fourth, Nike-Zeus. The Nike-Zeus plant was last because the schedule for Nike-Zeus production and deployment is not firm.

We are proceeding with plans to start design soon on the floating plant for the initial use in Korea. This is being programed under our R.D.T. & E., research development and test program of the Army.

Representative HOLIFIELD. What size plant is that?

General SEEMAN. The Korean one is in the 10,000-kilowatt range.

Due to the urgent need for power on Okinawa, we have proceeded to date with plans to install 80,000 kilowatts of conventional power there under legislation received last year under the civil functions program.

Representative HOLIFIELD. Was there consideration on the Okinawa plant of using atomic reactors rather than the conventional type?

General SEEMAN. There has been consideration off and on, Mr. Chairman, over the years. I can treat more fully on that in reply to your question in a moment.

Funds are available for this plant at Okinawa now. The Army supports the installation of nuclear capacity at Okinawa. This support, however, must be contingent upon the availability of additional funds. This also assumes resolution of a number of problems involving eventual ownership and operation of the plant on Okinawa.

We will consider further the requirements for plants at Asmara, Eritrea, and the Nike-Zeus sites, and for the many smaller plants which our studies indicate may be justifiable.

That completes the prepared remarks that I had, sir.

Representative HOLIFIELD. You already have the 80,000 conventional plant funded for Okinawa?

General SEEMAN. Yes, sir.

Representative HOLIFIELD. You said you would need additional funds for nuclear. Do you mean that you need additional electricity there, or do you mean that it would take additional funds to replace the conventional?

General SEEMAN. The 80,000 additional kilowatts is a firm requirement to meet the demands of the economy and the U.S. forces there for the foreseeable future. The estimated cost of that plant is in the neighborhood of $23 million, which resources are in hand. Of this amount $18 million was authorized and appropriated by the Congress last year to be loaned by the Army to the Ryukyu Electric Power Corp.

In addition, the plan is to provide nearly $5 million of funds which are available to that public corporation to meet the full cost of this 80,000 kilowatts by conventional power sources.

Representative DURHAM. Are they qualified to run that type of plant?

General SEEMAN. The plant actually at the present time, Mr. Durham, is being operated by the Army.

Representative DURHAM. I am talking about if you build a new nuclear-powered plant.

General SEEMAN. I would see no reason that it could not be operated similar to the reactor at Belvoir and our plans to operate the one at Fort Greely.

Representative DURHAM. Have those plans been worked out definitely and is there an agreement with the Okinawans?

General SEEMAN. As far as approaching them on the use of a nuclear plant in the Okinawa economy, this has not gone to that stage yet.

Representative DURHAM. I am thinking about your projecting that in your viewpoint and planning.

General SEEMAN. Not quite to that extent, sir. The power requirements are so immediate that we have had to go to the conventional-type power within the limits of the authorization that we now have. We tried some years ago—I do not believe it reached the Congress—under MCA, "Military construction, Army," to meet the additional power requirements, but due to the peculiar situation on Okinawa and the involvement with the civilian economy, we did not achieve success. So another avenue was taken and we now have the authority of the Congress under the civil functions.

Representative DURHAM. In other words, you think you can do it much quicker by this?

General SEEMAN. Yes.

Representative DURHAM. Did you make any study as to the differential in time?

General SEEMAN. The present plan is that of the 80,000 kilowatts conventional that could be brought on the line starting in March of 1963, and if a solution could be worked out so that a portion of this 80,000 kilowatts, and we have been thinking in terms of 50–50—40,000 conventional and 40,000 nuclear—if the 40,000 increment nuclear, and it has been estimated that it would take about 6 months longer—if that 40,000 could be brought on the line along about the same time as the last two 20,000 segments of the conventional power, then as far as timing is concerned to meet the requirements, it would be entirely acceptable.

Representative DURHAM. I am sure you gave consideration to the fact, of course, that all your fuel will have to be transported there over the life of the plant, whatever it is, 10 or 20 years.

General SEEMAN. That is correct, sir.

Representative DURHAM. That will be quite an expensive item. It is a long way.

General SEEMAN. Yes, sir. This is one of the main considerations of the advantage in logistics of the nuclear-type plant.

Representative HOLIFIELD. The 6 months, was that the controlling item in making your decision, or is it the differential in cost?

General SEEMAN. I would not say that any one of them is the controlling item, sir. The differential in cost and our subsequent operation is perhaps the largest problem.

Representative VAN ZANDT. What are the cost figures?

General SEEMAN. The present estimate is that to go for 40,000 of the 80,000 in nuclear would require an additional cost of about $12 to $15 million.

Mr. RAMEY. But you would have possible savings in fuel, would you not, so it might even out, if you considered your per-mill cost over the life of the plant?

General SEEMAN. Sir, we have not fully studied this out. The report which I understand the Commission is preparing for you, for which they secured the Kaiser engineers' study, compares two 40,000-kilowatt plants and gives the relative costs—disadvantages and advantages.

The actual application of that to the situation that we are under in Okinawa has not been thoroughly studied. This is a problem.

Mr. RAMEY. That is certainly the case in this Guam plant. We have had testimony that on any nuclear plant as compared to a conventional plant, there is a higher capital cost, but over a period of time they begin to even out if you compare your fuel costs.

General SEEMAN. That is correct. I believe the study, which has not been thoroughly evaluated by the Commission or by the Army, indicates that in a comparison between a conventional plant and a nuclear plant, 40,000-kilowatt capacity, that it would take about 12 years before the savings would begin to accumulate.

Representative HOLIFIELD. In other words, at the present time this would be an increased capital plant investment of $12 million?

General SEEMAN. Yes, sir.

Representative HOLIFIELD. There is the possibility that that $12 million would be recovered in 12 years in the savings of fuel in transportation?

General SEEMAN. The application cannot be taken straight across to the Ryukyu situation because of the peculiarities under which we operate there.

Representative HOLIFIELD. What do you mean by the peculiarities under which you operate?

General SEEMAN. The power must be integrated into the system which we have at this time. The Ryukyu Electric Power Corp. is a public corporation set up by the High Commissioner to fulfill this requirement. It had been determined that the public corporation must adhere to U.S. Government policies and principles expressed by the act of Congress which covers this. Present policy requires that a 5-percent return be charged to the value of the plant.

This is one of the requirements which an increased first-cost seriously would handicap.

Representative DURHAM. Is that a subsidiary power company?

General SEEMAN. No, sir; it is an instrumentality of the civil administration of the Ryukyu Islands under the High Commissioner.

Representative HOLIFIELD. In other words, I understand you operate this as a public utility and you charge the natives of Okinawa for the electricity that they receive.

General SEEMAN. Yes, sir.

Representative HOLIFIELD. And they, in turn, have to pay enough in order to operate the plant and the 5-percent return on the capital investment; is that what you are telling us?

General SEEMAN. That is correct. One of the requirements of the High Commissioner is to foster the economy of the island. This requires keeping these power rates at the lowest possible level.

Representative DURHAM. Is all that 5 percent charged against the natives out there or do we participate in some of that?

General SEEMAN. It is charged in in developing what the rates will be for all users.

Representative HOLIFIELD. But we take our pro rata share for the military uses?

General SEEMAN. Yes, sir.

Chairman ANDERSON. Would 5 percent make any difference in the economic feasibility of the plant?

General SEEMAN. Yes; it would, very definitely.

Chairman ANDERSON. How, from an accounting standpoint, would it? If you take it out of one pocket and put it in the other pocket, you still own it. What is the difference?

General SEEMAN. This is a question. To a certain extent, the rates charged the military, too, must accommodate this.

Chairman ANDERSON. That does not go into feasibility, does it?

General SEEMAN. It goes into feasibility as far as the Army budget and the High Commissioner's mission are concerned.

Chairman ANDERSON. You could just as well make it 50 percent, could you not, on paper, and still come out with the same amount of money?

General SEEMAN. As far as the overall—you have much more experience in this than I have, sir.

Chairman ANDERSON. If the Army puts its money into a building such as this one and says they are going to charge the House $100 million a year and the Senate $50 million for the rent of it, the Government will not be a bit better off at the end of the year because it charges itself and receives itself. What has the 5 percent to do with it?

General SEEMAN. It is an intergovernmental transaction.

Chairman ANDERSON. What intergovernmental agency gets the money? To whom do you pay the 5 percent?

General SEEMAN. It would be charged——

Chairman ANDERSON. Somebody in the back wants to answer.

General SEEMAN. It would be charged as far as the Army is concerned to its maintenance and operation appropriation. It would be charged to the private consumers, such as they are, in their rates.

Chairman ANDERSON. I understand their 5 percent. But what has the Army's 5 percent got to do with the feasibility of this reactor?

Colonel VIEMAN. Sir, this 5 percent is a return on the depreciated value of the capital plant which the Ryukyu Electric Power Corp. is required to earn. Therefore, the power rates charged consumers must cover not only the operation of the plant, the cost of fuel, main-

tenance, and management of the plant, but depreciation reserve on the physical plant, plus a 5 percent return on the depreciated value of the capital plant.

Chairman ANDERSON. I understand that. That is all right for the natives. But what difference does it make to the Army whether it takes 5 percent out of one pocket and puts it in the other pocket or not?

Colonel VIEMAN. It makes no difference to the Army.

Chairman ANDERSON. Then how does it affect the Army's feasibility? Is the Army the only user of this power?

Colonel VIEMAN. No, sir.

Chairman ANDERSON. How much do the natives use of it?

Colonel VIEMAN. About 25 percent. The military services use 75 percent, mainly the Navy and Air Force.

Chairman ANDERSON. You would not use that 5 percent then, to determine the feasibility of the 75 percent, would you?

Colonel VIEMAN. Not with respect to the 75 percent, sir. The feasibility in our mind hinges on the cost of power to the consumers. As General Seeman has said, it is essential to the High Commissioner's mission that he keep that cost to consumers out there a low as possible so that he can proceed with his mission of developing the economy.

There has to be some means of accommodating this requirement with the requirement for a 5 percent earning on the value of the capital plant.

Chairman ANDERSON. If you made it 10 percent, you would make the reactor a little less feasible, would you not?

Colonel VIEMAN. Yes, sir.

Chairman ANDERSON. Whatever figure you needed to make it infeasible, you could use?

Colonel VIEMAN. We are not trying to make it infeasible, sir. We would like to have the plant. The point is that if the value of the capital plant is increased, say by $12 million, by substituting nuclear components for some of the conventional components, then this 5 percent must be earned on the additional $12 million.

In this example, it would be about $600,000 a year more than the REPC would have to earn through charges to their consumers than they would if we built it all conventional

Chairman ANDERSON. Is there a law that requires that?

Colonel VIEMAN. This is a directive from the Bureau of the Budget, sir.

Chairman ANDERSON. We can change that, can we not?

Colonel VIEMAN. I presume you could, sir.

Chairman ANDERSON. The law of the land would still be a little bit above the Bureau of the Budget. Not much, but a little bit above it.

I just do not understand why, if you are going to have an argument, if it is feasible or not feasible, you do not deal with the economic circumstances of it and not add in the charge that you have to have when you deal with the natives, but which does not matter when you are talking about the Army use of it.

On the same principle, we could have said that the Shippingport reactor had to earn 5, 10, or 15 percent on the $100 million, and we could not do anything with it except to close it down.

General SEEMAN. We have said we would support this plan. We have also indicated honestly what the other problems would be.

Chairman ANDERSON. Have you ever asked for it in a budget?

General SEEMAN. No, sir.

Chairman ANDERSON. Is that not the best kind of support?

General SEEMAN. Yes, sir; but it requires the approval of our higher authorities to do that.

Chairman ANDERSON. Yes; I realize that.

General SEEMAN. Another angle on this, if I might take another second, Mr. Chairman, is that the $18 million loan authorized by the civil functions supplementary in fiscal 1960 for this also carries a provision that repayment commence within 5 years after the money is made available by the Treasury. This must be repaid over a period of 25 years.

Representative HOLIFIELD. Out of your budget, out of your annual budget, and the receipts?

General SEEMAN. Out of the operating accounts of the REPC.

Representative HOLIFIELD. But 75 percent of that comes out of your budget and 25 percent from the natives.

General SEEMAN. That is the general proportion of the power requirements. The Secretary of the Treasury also is required to set the rate of interest on that loan, and I believe he has set 4¼ percent as the official interest that that loan would have to carry in addition to being repaid over a period of 25 years.

Representative HOLIFIELD. So the problem we face, then, is really the fact, and the significance of this 5 percent is that this would affect your annual budgets each year and cause the Army to have to ask for more money to pay the 5 percent on the differential between the nuclear and the conventional unless the operating costs each year offset it enough to take care of it.

Apparently, from what you have said, it would take 12 years of operation to amortize this additional $12 million.

General SEEMAN. It would take 12 years according to the study made by the Kaiser engineers before it would start paying off. Actually, the life considered in this study was a 20-year life. So for the last 8 years it would be completely in the black as far as fixed and operating charges go.

Representative HOLIFIELD. So the only detrimental effect in your changing this from a conventional to a nuclear plant would be your additional 5 percent on the differential plus the 6 months' additional time it would take you to construct it over the conventional?

General SEEMAN. That is correct.

Mr. Chairman, in all fairness, that is an estimate. Still it would have to be studied out. At this stage of the game, this 6 months plus or minus on procurement is hazy.

Representative VAN ZANDT. General, how much money have you set aside for this 40,000-kilowatt conventional plant in Okinawa?

General SEEMAN. We have not actually set it aside. We have authority. The requirement is for 80,000 kilowatts, and the funds available are estimated to procure that amount of power. Those funds are $18 million by authority of the Congress for a loan from the Army to the Ryukyu Electric Power Corp., and $4 million to $5 million available in their own resources.

So the total cost of the 80,000 conventional is in the $22 million to $23 million range. The total cost considering half of that as a nuclear plant is estimated to be in the $35 million to $38 million range.

Representative VAN ZANDT. $12 million more?

General SEEMAN. Yes, sir; $12 to $15 million. Under the present methods of operation, if the cost of that goes up, the economy and the other budgets of the services would not rightfully stand the difference in cost. That would be required both in the fixed charges and in the repayment of the loan.

Representative VAN ZANDT. What is our status in Okinawa at the moment?

General SEEMAN. As far as Defense is concerned, the position of Okinawa in our worldwide military posture is immeasurable. As you know, our tenure there is somewhat different than the status of forces agreements among other countries.

Representative VAN ZANDT. In other words, we are an occupational force there; are we not?

General SEEMAN. Not actually.

Representative VAN ZANDT. And under a trusteeship?

General SEEMAN. Yes, sir.

Representative VAN ZANDT. The trusteeship could be terminated, resulting from an agreement between Japan, say, and the United States? Or is it a four power or three power?

General SEEMAN. I am not too sure about this, sir, but there has just been recently a treaty with Japan and the understanding is that the tenure is not a limited one as of this time. Of course, the world situation changes from year to year.

Representative VAN ZANDT. The only source of heat out there is oil; am I correct?

General SEEMAN. That is correct.

Representative VAN ZANDT. There is no coal and no gas?

General SEEMAN. That is correct.

Representative VAN ZANDT. Where do they transport the oil from?

General SEEMAN. My understanding is that the fuel oil is transported from the Middle East.

Representative HOLIFIELD. How far is that?

General SEEMAN. Actually in mileage it is several thousand.

Representative VAN ZANDT. Probably 3,500 miles.

Colonel WILLIAMS. I do not know what the distance is, sir, but the cost of fuel oil per gallon at Okinawa, according to our Kaiser study made for the committee, is $0.104 per gallon. That is 10 cents a gallon.

Representative HOSMER. Ten and a half cents a gallon?

Colonel WILLIAMS. Yes.

Representative HOSMER. How does that compare with fuel oil laid down in the United States from the Middle East?

Colonel WILLIAMS. I would say under that condition fuel oil would be in the neighborhood of 14 cents a gallon.

Representative HOSMER. Do you mean here in this country?

Colonel WILLIAMS. Say from Venezuela to the Thule area.

Representative HOSMER. How far is it from Venezuela to the United States per gallon?

Colonel WILLIAMS. Probably 12 cents.

Representative HOSMER. It is cheaper over there than it is here, then.

Chairman ANDERSON. It seems to me we were told this plant was desirable because fuel costs were high. Now do you tell us fuel costs are low?

Colonel WILLIAMS. Sir, even though these fuel costs are 10 cents a gallon at Okinawa, for a 40,000-kilowatt electrical plant, nuclear, the cost in mills for nuclear is somewhat less than for conventional.

Representative VAN ZANDT. Can you furnish those figures?

Representative HOSMER. You have economic power when your conventional fuel is cheaper over there than it is here.

Colonel WILLIAMS. For military purposes; yes, sir.

Representative BATES. What do you mean by "military purposes"? Is somebody else paying for it?

Colonel WILLIAMS. For the 40,000-kilowatt nuclear plant the initial cost is around $24 million. The annual DOD budget cost is $1.5 million, roughly, and the cost of power, mills per kilowatt-hour, including this annual budgeted cost and 5 percent depreciation of the initial cost, comes out at 9.5 mills per kilowatt-hour.

Representative HOSMER. That is for nuclear?

Colonel WILLIAMS. That is for nuclear. For the conventional, the initial cost for this 40,000-kilowatt plant is about $11 million, according to the Kaiser report, and the annual DOD budgeted cost is about $2.6 million operating costs, and the cost of power, again, considering the annual budgeted cost plus 5 percent of the initial cost, comes to 10.9 mills per kilowatt-hour.

Chairman ANDERSON. I do not quite follow why you go from $11 million to $2.6 million, when you go from $24 million to $1.5 million.

Colonel WILLIAMS. These are the Kaiser estimates, sir, on the amount of fuel that would be consumed. Principally, this $2.6 million annual budgeted cost is a matter of fuel consumed.

Chairman ANDERSON. What is the fuel cost alone?

Colonel WILLIAMS. Which portion of the $2.6 million is fuel alone, of the annual operating cost?

Chairman ANDERSON. They have certainly figured out what the fuel cost will be per kilowatt-hour on the use of oil at 10 cents a gallon.

Colonel WILLIAMS. Yes, sir; that is 8.4 mills for the conventional plant.

Chairman ANDERSON. Then how can any electrical plant in the United States that pays 12 cents operate at all and get a fuel cost of 6 mills or below?

General SEEMAN. The problem here, if I might intrude, sir, is the balance between your fixed charges and your operating charges. The fixed charges on a $23 million estimated cost nuclear plant are a large part, and your operating charges, the oil and number of people involved, are the large part of the conventional plant. The balance of this is what causes the results in the figures that have been given.

Chairman ANDERSON. Can we start again?

General SEEMAN. Yes, sir.

Chairman ANDERSON. The conventional plant runs $24 million?

General SEEMAN. The nuclear plant does.

Chairman ANDERSON. And the conventional plant $11 million?

General SEEMAN. Yes, sir; in the Kaiser report.

Chairman ANDERSON. And your fuel cost is only 10 cents a gallon on oil. What do you come out to on a charge, what is your fuel charge, per kilowatt-hour developed? How many mills?

General SEEMAN. I do not believe the Kaiser study brought that down.

Colonel WILLIAMS. We do not have the fuel charge alone broken out on that.

Chairman ANDERSON. How can you make a study without knowing what it costs you for fuel?

Colonel WILLIAMS. I do not have that.

Captain Gow. It is 8.4 mills.

Chairman ANDERSON. I thought it would be closer to 6.

The nuclear plant costs 9 mills. So you say in 12 years the savings by using 9-mill power to 8-mill power will pay it out?

Colonel WILLIAMS. Yes, sir.

Chairman ANDERSON. There must be volume to do that.

Representative HOSMER. Is that 8.4 nuclear or conventional?

General SEEMAN. The 8.4 mills is the fuel portion of the 10.8 mills cost of power from the conventional plant.

Representative HOSMER. And your annual depreciation is 0.55. So that should bring your per-mill cost to 8.85 for conventional rather than the figure of 10.9 that you gave; would it not?

General SEEMAN. I am not acquainted fully with this study. This is the Commission's study, sir.

Representative HOSMER. Have you anything else besides capital and operating costs?

Captain Gow. There are additional operating costs involved, the cost of the plant labor, repair, parts.

Representative HOSMER. This $1.5 million you gave us for an annual operating cost of the nuclear plant is not a proper figure, then, is it?

Captain Gow. Sir, these are included in there.

Representative HOSMER. They are included in where?

Captain Gow. Our annual budgeted costs include the operator labor.

Representative HOSMER. How about the $2.6 million then, for the conventional? Does that include the operator labor?

Captain Gow. Yes, sir.

Representative HOSMER. If you take the nuclear plant, your cost is $24 million—taking on a 20-year amortization. You get $1.1 million a year. Then you add your annual operating cost and you get $1.7 million; is that right?

Captain Gow. Yes, sir.

Representative HOSMER. Then your similar figures on the conventional plant run to $3.5 million for the conventional plant. However, that does not jibe with the figures you just gave for your cost of the fuel in the conventional plant being 8.4. That is what I am trying to find out; What that 8.4 figure is.

Colonel WILLIAMS. That is the fuel oil cost, sir. That is the actual fuel oil cost.

Representative HOSMER. But there are some other costs in addition?

Colonel WILLIAMS. Yes, sir.

Captain Gow. Not in that figure. The 8.4 mill is fuel oil.

Representative HOSMER. Fuel oil only?

Captain Gow. Yes, sir.

Representative HOSMER. Then I cannot figure, if your $1.5 million annual operating cost for your nuclear plant includes labor and everything, why does not your $2.6 million annual operating cost include the same thing? or does it?

Captain GOW. It does.

Representative HOLIFIELD. I think we are going into details on this. After we get the April 1 study we will go into detail.

Colonel WILLIAMS. Yes, sir.

Chairman ANDERSON. Will you supply us with a copy of this Kaiser study?

Colonel WILLIAMS. We have done that.

General SEEMAN. If it pleases the chairman, I might mention a little bit what the present power is over there to give the committee the picture.

At present there is a steam powerplant at Machinato of about 46,000-kilowatt capacity. The other power presently is provided by two floating plants, which are the property of the services. And there are miscellaneous diesel plants. Also, the transmission lines between these plants are a part of the Ryukyu Electric Power Corp. property.

This is the problem we are up against. It is rather an expensive hodgepodge of plants and floating plants that have to be tied into it.

Representative DURHAM. We built all of those out of funds.

General SEEMAN. Yes, sir. And the diesel plants are the high-cost plants.

Representative DURHAM. The plants operating at the same time: Is that the same formula you are projecting here, at 5 percent?

General SEEMAN. Yes, sir. The REPC plants must yield a return on the investment.

Representative DURHAM. That is as of today?

General SEEMAN. Yes, sir.

Chairman ANDERSON. Are all of these the powerlines that the Federal Government built in time of emergency; are they under the 5 percent?

General SEEMAN. That under the Ryukyu Electric Power Corp.; yes, sir. They must provide a return, similar to the policy expressed in Public Law 248 of the 79th Congress.

Chairman ANDERSON. Is that the Butler-Byrd bill that you are talking about?

General SEEMAN. I do not know, sir.

Representative HOLIFIELD. I think it is. The purpose of it was to fund all of these Government corporations on a standard basis of accounting so that we could understand what the actual cost of their operations was.

General SEEMAN. Yes, sir. Whether it should be applied to this operation of U.S. forces which have a very special mission of fostering the economy and supporting the military forces. There has been argument on this as to its application.

Representative VAN ZANDT. So as to complete this picture, do we understand that all power produced on Okinawa is centralized in the hands of this power corporation?

General SEEMAN. The REPC owns the Machinato plant and the transmission lines and leased them to the Army which operates them together with the U.S.-owned facilities as an integrated system.

Representative VAN ZANDT. And that none of your camps over there have their own generating plants?

General SEEMAN. Some remote activities have small diesel plants which do not form a part of the net that I described.

Representative VAN ZANDT. That answers the question.

Chairman ANDERSON. But if you put in one large system, would you still have to carry all of these antiquated powerlines that were built for emergency use and that have no practical value to you?

General SEEMAN. Senator, they would require a certain amount of them to be retained for an eventuality, to be cut off in case of military action or something like that. But there is no question that a large number would be put out.

Chairman ANDERSON. But would they still be carried on the inventory and 5 percent charged against them?

General SEEMAN. No, sir.

Representative HOLIFIELD. Let me clear this, if I can, in my own mind. The thing that you are worried about as far as the Army budget is concerned is the $12 million differential in capital plant investment and the charges of carrying that annually?

General SEEMAN. That is correct.

Representative HOLIFIELD. If that amount of money was supplied by the AEC budget, on the basis of its research and development program—and we do have a precedent for this in the process heat reactor which we are building—would that take this worry off your shoulders?

In other words, would you be in a position then to do more than just be for this and actively come out and sponsor this?

General SEEMAN. Mr. Chairman, you have laid the circumstances by which the Army says it supports this plant wholeheartedly.

Representative HOLIFIELD. That is what I wanted to find out. I knew you were worried about the $12 million. Otherwise, you would get behind this?

General SEEMAN. Yes, sir; very much so.

Chairman ANDERSON. Is that not the fact, that the AEC has gone ahead with some second-round proposals—that it made this sort of proposal to the Navy at Guam, but the Navy would take the conventional cost and it would assume the incremental cost of it? Would you be agreeable to that sort of proposal?

General SEEMAN. Yes, sir. I think this highlights the problem of application of nuclear power anywhere. It is the problem of the high fixed charges—the first cost, versus the lower eventual operating cost.

Representative HOLIFIELD. Which raises your annual budget and you have to come in and ask for more money.

General SEEMAN. Yes, sir.

Representative HOSMER. I have two nonfinancial questions I would like to ask.

Your remarks about the status of Okinawa being one that is not fixed for a large number of years ahead—and also your statement about the possibility of attack—raise these two questions:

First, this plant requires 20 years, actually, to pay out—the nuclear plant, compared to the conventional—or 12 years at least before you start getting into the black on it. How much consideration have you given to the fact of whether or not you would still be there in 12

years; and, second, since there is a possibility of attack and destruction of these and other installations on the place, would it not be better that the more conventional equipment that can be replaced more rapidly in the event of attack should be the prime consideration for installation? Would you comment on both?

General SEEMAN. As far as the tenure is concerned, sir, your view of world operations is better than mine. But the Army sees no finite limit as to this tenure. This is a part of our worldwide military posture at this particular time.

Representative HOSMER. You are operating under a United Nations mandate plus some kind of an arrangement with the Japanese, are you not?

General SEEMAN. I do not believe there is a United Nations mandate involved. But there I am out of my depth.

Representative HOSMER. What does the term "High Commissioner" connotate to you?

General SEEMAN. This is the U.S. Government procedure for administering this island. The High Commissioner is appointed.

Representative HOSMER. In other words, it is purely an occupational situation?

General SEEMAN. It is our method of governing where you have civilian people and economy to administer along with your other.

Representative HOSMER. You feel that this is a permanent arrangement?

General SEEMAN. For the foreseeable future.

Representative HOSMER. For 20 years; is that within the foreseeable future?

General SEEMAN. As foreseeable as any of the things in this changing world.

Representative HOSMER. Let us get down to the question about the replacement in the event of attack.

General SEEMAN. A 40,000-kilowatt portion of the total of around 125,000 to 150,000 would not be serious. Your operating plan must provide for periodic shutdowns of portions of your plant to refuel, to repair, to renovate.

The factors of safety in building the structure of a nuclear powerplant type, as you well know, are strict. It is much more massive type of structure sometimes than our open, conventional plants.

Representative HOSMER. By that do you mean——

General SEEMAN. I would not be concerned particularly about the nuclear plant.

Representative HOSMER. You could sacrifice the 40,000 kilowatts more easily in time of war or attack than you could in time of peace?

General SEEMAN. I do not think you would consider it in terms of the word "sacrifice" considering all of the other elements of getting tankers of fuel in there during a military situation.

Certainly the flying in of the additional atomic fuel, or the moving in, is not disadvantageous at all.

Representative HOSMER. Those are questions that we should have answered on the record.

Representative HOLIFIELD. Thank you, General.

Representative BATES. This is $24 million for a 40,000-kilowatt plant; is that correct? I thought when we had the Navy on the Guam one, that that first increment was regular steam for 20,000,

the next increment was going to be 20,000, and the Navy was going to pay $9 million something, the AEC a little over $11 million, coming to $20 million, and then over $23 million, and that was for 20,000 kilowatts. Now we are going to get double the amount for $24 million?

General SEEMAN. No, sir. The $24 million was the Kaiser engineer's estimate of a 40,000 complete. The additional cost at Okinawa to put in 40,000 would be in the range of $12 to $15 million.

Representative BATES. You are getting an atomic reactor for $24 million?

Mr. TOLL. No; it is $36 million.

Representative BATES. You get that $12 million extra.

General SEEMAN. The total of 40,000 conventional and 40,000 atomic would be $35 million to $38 million.

Representative HOLIFIELD. That is 80,000 kilowatts.

We will have the Navy on in a short while.

Representative VAN ZANDT. There are four reactors involved here. One at Okinawa, and one in southern Turkey. Is that our base in Turkey?

General SEEMAN. Asmara is a joint base which is very important.

Representative VAN ZANDT. Where is the third one?

General SEEMAN. The floating plant for Inchon, Korea.

Representative VAN ZANDT. And then the fourth is Nike-Zeus?

General SEEMAN. It was an application for Nike-Zeus, dependent upon the future of that weapons system.

Representative VAN ZANDT. What are your figures on Turkey?

General SEEMAN. Colonel Williams, I think, has an estimated cost for Asmara, Eritrea.

That was the 5,000-kilowatt consideration. The total project cost tentatively was $6 million plus.

Representative VAN ZANDT. That is nuclear power?

General SEEMAN. Yes, sir.

Representative VAN ZANDT. What about Inchon?

General SEEMAN. Inchon was a 10,000-kilowatt floating plant at an estimated cost of $11.5 million.

Representative VAN ZANDT. And Nike-Zeus?

General SEEMAN. The Nike-Zeus, those were 10,000-kilowatt increments at an estimated cost of $11.8 million.

Representative VAN ZANDT. Are these reactors going to follow the Army's program of a packaged reactor?

General SEEMAN. They would build upon the experience that we have had so far.

Representative VAN ZANDT. The packaged reactor you are working on at the present time?

Colonel WILLIAMS. Sir, these plants that we have been talking about this morning are too large to be prepackaged. The 5,000-kilowatt size, the plant we call the SM–2 plant, we hope some day

that we will be able to package this, but we are not chewing this off at this stage.

Representative VAN ZANDT. This program is separate and distinct from your package reactor program at the present time?

Colonel WILLIAMS. Yes, sir. We have packaged plants in the 2,000-kilowatt range.

Representative VAN ZANDT. Thank you.

Representative HOLIFIELD. Thank you very much, General. We will go into this further, of course, after we get our April 1 report.

We would like to ask that Adm. John L. Chew, U.S. Navy, Director, Military Construction and Maintenance Division, Office of the Chief of Naval Operations, and his staff come forward.

STATEMENTS OF REAR ADM. JOHN L. CHEW, U.S. NAVY, DIRECTOR, MILITARY CONSTRUCTION AND MAINTENANCE DIVISION, OFFICE OF CHIEF OF NAVAL OPERATIONS; CAPT. LEWIS C. COXE (CEC), U.S. NAVY, ASSISTANT CHIEF, PLANNING AND DESIGN DIVISION, BUREAU OF YARDS AND DOCKS; AND COMMANDER CHRISTIANSEN, CIVIL ENGINEER, ATOMIC ENERGY AND APPLIED SPECIALISTS, BUREAU OF YARDS AND DOCKS, DEPARTMENT OF THE NAVY

Admiral CHEW. Mr. Chairman, I would like to speak briefly to the two areas of Guam and the Antarctic. With your permission, I would like to speak to Guam first, and perhaps Captain Coxe can give you more of the detailed information on the Antarctic.

As regards Guam, Mr. Chairman, we had in our last year's military construction authorization bill $10.9 million for the construction of a conventional plant.

Representative HOLIFIELD. Fiscal 1960?

Admiral CHEW. Yes, sir. This was authorized but not approved for funding. During the ensuing planning period, in the hearings last year, we testified as to the urgency of the need for this additional power.

As you know, sir, the Navy is responsible for furnishing the power requirements on Guam. This was an increased powerload that was urgently needed. The load was increasing at such a rate that we urgently needed the plant.

Representative HOLIFIELD. How many kilowatts was that?

Admiral CHEW. It was 20,000, to be two increments, 20,000 kilowatts each.

Representative HOSMER. For 40,000?

Admiral CHEW. No, sir; the first increment in 1960 was for 20,000 kilowatts, for a total of $10.9 million.

At that time, the question of the atomic plant came up, but because of the time necessary to complete an atomic plant—and I might add

that this was to be a relocatable, barge-mounted type of atomic reactor, the decision was made, because of the urgency, to request the first increment as a conventional plant.

This has been borne out, Mr. Chairman, by the fact that the load has increased so that it has become necessary for us, and we have at the present time on the way out there, to send a railway-mounted, 10,000-kilowatt unit to take care of this peakload that is developing on Guam.

Representative HOLIFIELD. Will you give me the number of the unit again?

Admiral CHEW. 10,000 kilowatts.

Representative DURHAM. What does it cost you?

Admiral CHEW. It is going to cost us in the neighborhood of $200,000 to ship it out there, sir. This is a part of our mobilization stock. We are shipping it to Guam at an approximate cost of $200,000. That cost, primarily, Mr. Durham, is to bring it into Apra Harbor, lay a track, move the generator to the Piti plant.

Guam, as you probably remember, has a basic steam generating plant at Piti of about 33,000, if my memory serves me correctly, kilowatts, and then some 22,000 or 21,000 various and assorted diesel-generating units.

Representative DURHAM. What brought about the demand for this increase in power on Guam?

Admiral CHEW. The demand was brought about by two things, sir: The increased civilian load and the increased military load, both from the Air Force and the Navy.

Going one step further, sir, during the year in which the 1960 increment was not funded, we have investigated, and the Secretary of the Navy had said that if the government of Guam would fund the conventional increment, that we, the Navy, would prefer to put the funds that we now have in the present military construction funding on an atomic plant.

Representative DURHAM. You did a good selling job. You were authorized over there for a year and a half, and your demands are still growing for power. Somewhere along the line you stumbled or something.

Admiral CHEW. It was authorized, but it was not approved for funding.

Representative DURHAM. I remember the item.

Admiral CHEW. That is correct, sir.

Representative DURHAM. It was laid down as very urgent by the Navy.

Admiral CHEW. I think very possibly it was not completely understood that the reason for the conventional plant in the 1960 program was because of the urgency.

Mr. TOLL. If you study this second increment long enough you will run out of time on that one, too, will you not? You eventually will have urgency, if you procrastinate long enough, to build a conventional plant there, also.

Admiral CHEW. I think, sir, if the conventional plant goes, we have our power requirements pretty well predicted. We know we will need another increment. I think, quite frankly, with the shipping of this temporary generator, which should not stay there because it is a mobilization stock item——

Representative DURHAM. That is a diesel-operated type?

Admiral CHEW. No, sir; it is a steam generator and run right on its railway car.

Representative VAN ZANDT. What is the capital cost of this unit?

Admiral CHEW. Perhaps Captain Coxe can answer that.

Captain COXE. I haven't got the figures exactly, but it is in the neighborhood, as I remember, of about $1½ million.

Senator JACKSON. It is already in existence?

Captain COXE. Yes, sir.

Chairman ANDERSON. It is an old plant?

Captain COXE. Yes, sir. It was procured about 8 or 9 years ago.

Chairman ANDERSON. What happened to the civilian load? How much has it gone up?

Captain COXE. The increase is continuing because of two reasons, one being the number of Guamanians is increasing, about 3 percent a year, but the major cause is that they have become acquainted with television and washing machines, irons, and the electrical world. That is the major cause for the increase.

Chairman ANDERSON. I see.

Captain COXE. Sir, you can drive by and see a broken down old shack sitting up on a couple of stilts there, and it has a television antenna on top of it.

Chairman ANDERSON. How much has the military load increased?

Captain COXE. The military load, up until this year—for instance, the Navy's load has increased from 13,860 kilowatts in 1958 to about 17,300 this year, 1960.

Chairman ANDERSON. Are there more personnel there?

Captain COXE. No, sir; it is not a matter of personnel. It is increased facilities.

Chairman ANDERSON. Do you have television and washing machines?

Captain COXE. Well, that may affect the dependents.

The Air Force, due to developments at Anderson Field, has gone from about 9,400 kilowatts up to 12,200. At the same time, the Government of Guam has gone up from 11,600 to 13,200.

Chairman ANDERSON. That is 11,600. You are long way from 20,000 yet; are you not?

Captain COXE. The total load on Guam at the present time, 1960, is 47,000 kilowatts.

Chairman ANDERSON. I mean the increase.

Captain COXE. The increase is such at the present moment that Guam is on daylight time in order to conserve electricity. This emergency unit has to be there by the middle of this summer in order to assure a firm power. That, as you know, is not total connected power, but a firm power requirement, to keep ability to meet the requirement.

This temporary unit which is going out and which will be installed by the middle of this summer will extend that period of grace, you might say, up until the middle of the last quarter of calendar 1964. So we have to get a 20,000-kilowatt plant in between now and the middle of 1964.

Mr. RAMEY. When was this Navy decision to proceed with the conventional plant made? The committee has testimony from the

AEC that they submitted to the Bureau of the Budget an item of $11,600,000 to pay the incremental cost on this plant.

Admiral CHEW. That is quite correct, sir, because this was in the 1960 budget that we had the conventional plant. We had hoped to go ahead with the conventional plant in 1960, and do the nuclear in 1961 as the second increment.

But when the 1960 was denied, it slipped into 1961. That was when the decisions was made, sir.

Mr. RAMEY. But the Commission proposal was in connection with your first increment; was it not?

Admiral CHEW. No, sir.

Mr. RAMEY. That was this fall; was it not?

Captain COXE. I would like to straighten that out a little bit. When we first became aware that the government of Guam might be interested in buying their own initial conventional 20,000-kilowatt plant, then we advised the AEC that in the event that they did that, we would anticipate shifting to nuclear power for the second increment 20,000 kilowatts in 1961.

The trouble has been that we have still received no definite decision from Guam as to yes or no, they are or are not. The time element caught us.

Representative WESTLAND. When I was in Guam, of course, the situation was discussed very much, and there is no question but that the Navy needs a 20,000-kilowatt plant out there. There is not much question in my mind but what the Guam government is going to buy a substantial portion of this.

Whether they can fund the whole thing or not, though, I am not sure, but I was told by the Governor of Guam they have a half million dollars in the kitty now. They show an annual profit of about $400,000 on the sale of power to the people of Guam. They are ready to appropriate additional funds necessary for the purpose of putting in a conventional powerplant.

I have a letter from CinCPac Fleet out there saying that they want a conventional plant, they do not want a nuclear powerplant, and they list the reasons why. One of them, of course, is the $11 million versus $24 million. The availability, the fact that it can produce at considerably less cost, are also important.

It seems to me that this is a proposition for the Appropriations Committee to fund this matter and get this 20,000 kilowatt plant out there. This is certainly an expensive way, as the Navy is doing it now, by shipping a 10,000-pilowatt plant clear out to Guam at a cost of about $200,000 just for the shipping. It is a complete waste of money in my opinion, and it should be properly funded.

Representative VAN ZANDT. Admiral, suppose the 10,000-kilowatt generator which is on its way out is no longer needed. Would you ship it back to the States?

Admiral CHEW. Yes, sir; it would be shipped back.

Representative VAN ZANDT. With another $200,000 in transportation.

Admiral CHEW. Possibly I might amend that. It would depend upon the need for the generating equipment at that time. It might be just as economical or more so to leave it out there, with the understanding that it would be shipped where it is needed.

Representative VAN ZANDT. This generating equipment is a mobilization requirement?

Admiral CHEW. This is mobilization stock; yes, sir.

I would like to speak to one other thing, sir. That is the fact that, as you know, the rest of the power equipment, the Piti plant of 30,000 kilowatts, is a good, reliable plant. But the rest of the equipment is old and it is a patchwork. We have really no reserve at all. It is just a question of holding it together in a great many cases with chewing gum and baling wire. That is the situatiton we are faced with.

Representative HOSMER. I may have heard wrong, but why does it cost you $10.9 million to put a 20,000 conventional plant on Guam, and it costs the Army only $11 million to put a 40,000-kilowatt plant on Okinawa?

Captain COXE. The $10.9 million that we have in the budget consists of two items, although they are lumped together. There is approximately, say, $7 million for the cost of the plant itself. The other $3 million is the improvements to the distributiton system in order to carry the additional loads, which is independent, you might say, of the plant construction. So there are two elements; the cost of the plant is in the neighborhood of $7 million.

Representative HOSMER. Are the Army people still here?

General, on that plant of yours at Okinawa, have you any transmission lines or anything else?

General SEEMAN. No, not in the cost that was given to you, sir. The transmission line system as presently envisaged there will accommodate the placing of this new plant with minor adjustments.

Representative HOSMER. Then, Captain Coxe, they can buy twice as big a plant on Okinawa for $3 million more than you can buy it on Guam?

General SEEMAN. Might I address myself to that question?

The estimated cost of a 40,000-kilowatt plant, itself, was $24 million. Colonel Williams will correct me if I am not right. A combination of 40 nuclear and 40 conventional was only $11 to $15 million additional.

Representative HOLIFIELD. The comparative figures, then, are $10.9 million by the Navy and $11 million by the Army.

General SEEMAN. As an additional cost on a base conventional. But if you consider the nuclear in isolation, it would be $24 million.

Representative HOLIFIELD. Are there any further questions on this?

Let me conclude this by saying that you have at this time no requirement. You are sponsoring no request for a nuclear plant on Guam; is that right?

Admiral CHEW. In the 1961 budget; no, sir.

Representative HOLIFIELD. And your reasons for that, I suppose, are the same as the Army, the impact on your budget, the differential between the nuclear plant and a conventional plant?

Admiral CHEW. Basically the reason is as I outlined, the urgency of it, and the fact that we can get the conventional plant on the line more quickly, a year quicker.

Representative HOLIFIELD. You are speaking of the first increment now?

Admiral CHEW. Yes, sir.

Representative HOLIFIELD. But on subsequent increments?

Admiral CHEW. The nuclear increment would be the next to be funded in the 1962 budget.

Representative HOLIFIELD. Are you planning to sponsor that?

Admiral CHEW. We are planning to sponsor that as a second increment; yes, sir.

Representative HOLIFIELD. Does that depend upon the joint funding of AEC and Navy?

Admiral CHEW. Yes, sir.

Representative HOLIFIELD. It does depend upon that?

Admiral CHEW. It does depend upon that.

Representative HOLIFIELD. So, again, your service is depending, budgetwise, on the AEC for the differential between the conventional and the nuclear plant?

Admiral CHEW. Yes, Mr. Chairman.

Representative HOLIFIELD. Are there any further questions?

Representative BATES. Why do you want the second one nuclear?

Captain COXE. For a variety of reasons. In the first place, at least in the Bureau of Yards and Docks, we are firmly convinced that nuclear plants are the coming thing, and the cost angle eventually will be worked out. Therefore, we want to get in the business as early as we can in getting the experience.

Secondly, we have planned out there a relocatable barge, which has a potential logistic capability for relocation to some other place if a greater emergency need arises.

Representative HOLIFIELD. Would this be a nuclear plant on a relocatable barge?

Captain COXE. Yes, sir. We have a photopicture of it. We can build this plant in the States, using stateside technicians, tow it out and jack it up on legs. I think, in itself, it is a very potentially important type of plant.

Representative HOLIFIELD. Have you considered the strategic part, that is, the supply of oil and so forth?

Captain COXE. Yes, sir. That is what I meant by the logistic elements in there.

Representative VAN ZANDT. May I ask the captain a question?

I am thinking now of the nuclear-powered carrier, crusier, or destroyer. Could you still place them alongside a dock and have them furnish power to a grid, such as you can do now with certain types of conventional ships?

Captain COXE. You are referring to the old *Lexington* when it went into Tacoma and lighted up the city?

Representative VAN ZANDT. That is right.

Captain COXE. The source of power would make no difference.

Admiral CHEW. No difference whatever. You can do that with any ship.

Representative HOLIFIELD. With the exception that on a barge type as this, you can build without regard to the size of the hold of the ship and you might be able to achieve a more economic source of power on a barge-type plant than you would on a cruiser type.

Admiral CHEW. Yes, sir; because you would not be faced with the military implications.

Representative BATES. Are you paying any premium for this barge type?

Captain COXE. We have just gotten an informal look at the Kaiser study and we have not been able to go through it in detail. But it appears that the cost of this relocatable barge type will be less than a plant shore based and constructed in Guam.

Representative BATES. That is because it is going to be done here and we have the people available?

Captain COXE. Yes, sir; where you have the people available. You have a cost factor on Guam of 1½ to 2 over the stateside cost. We feel it will be cheaper.

Representative BATES. I know that was one of the alternatives that we were considering.

Captain COXE. We think it is a very exciting type of project.

Representative HOLIFIELD. Why is it that it has to be placed on stilts?

Admiral CHEW. The reason for that, I think, as you know, is that there are a great many typhoons that go through Guam. Consequently, it has to be anchored firmly to the bottom.

Representative VAN ZANDT. From the strategic standpoint, how long would it take you to disengage this plant on the barge so that it could be moved or cleared from that area?

Admiral CHEW. I was going to say off the top of my head, Mr. Van Zandt, 25 to 30 days. Captain Coxe said approximately 30, and I am sure it is off the top of his head, too. But I think you could disconnect and relocate at another strategic area within 30 days.

Representative HOLIFIELD. If there are no further questions on the Guam reactor, we will take up the Antarctic.

I know that Senator Jackson is very much interested in this. He addressed a letter to me which I have already included in the record.

Senator JACKSON. Could we have it at this point in the record, too, Mr. Chairman?

Representative HOLIFIELD. Yes. We will insert it at this point in the record.

(The letter referred to follows:)

UNITED STATES SENATE,
COMMITTEE ON ARMED SERVICES,
March 8, 1960.

Hon. CHET HOLIFIELD,
Chairman, Legislation Subcommittee, Joint Committee on Atomic Energy, U.S. Capitol, Washington, D.C.

DEAR CHET: As you know, I visited the Antarctic during the last recess. My visit impressed upon me the great value of nuclear reactors for energy generation at our bases in the Antarctic.

I strongly recommend that your Legislation Subcommittee take steps to assure that authorization for nuclear reactor plants at our Antarctic bases be included in the Atomic Energy Commission's next authorization bill.

I think it is very important to proceed with such a project without delay. I believe we should consider suggesting to the ARC and the Navy that design work and procurement be initiated prior to the normal legislative process for the forthcoming year in order that advantage may be taken of the next construction season in the Antarctic, which starts in December.

During my visit I witnessed the logistic supply operation at our Antarctic bases first hand. Due to the extremely difficult and hazardous transportation conditions, the delivered cost of fuel oil is from $1 to $3 per gallon at McMurdo Sound Station, and between $7 and $10 per gallon at the South Pole station and Byrd station. To deliver 1,000 gallons of fuel from McMurdo to our South Pole and Byrd stations, each about 800 miles away by air, requires 4,500 gallons of airplane fuel. More than 70 percent of available cargo space on ships providing logistical support for our Anatarctic stations is taken up by fuel.

Considering the high cost of conventional fuels in the Antarctic, it appears that a significant economic advantage exists for the use of nuclear reactors at our bases in the Antarctic. In fact, savings of many dollars per year will probably be incurred if reactors are used to supply our energy requirements in the Antarctic. Estimates now available to the Joint Committee indicate that over the 20-year life expectancy of nuclear reactors their use in the Antarctic would

cut the cost of energy requirements there to as low as one-quarter the present cost of conventional powerplants.

In addition to monetary savings such projects would contribute directly to the development of our knowledge in the atomic power field in general.

A third advantage I see in proceeding with such projects concerns our international prestige. As you know we are engaged in scientific programs with 12 other nations in the Antarctic. The adoption of nuclear energy to further our scientific efforts and to ease the physical discomforts of our people living in the Antarctic I'm sure will greatly increase our international prestige.

Please feel free to call on me any time you think I can be of help in getting this important work underway.

Sincerely yours,

HENRY M. JACKSON, *U.S. Senator.*

Representative HOLIFIELD. We will have testimony now on that subject.

Senator JACKSON. Mr. Chairman, might I make a comment?

The Senate is in session, and I may have to go upstairs. I have a brief comment in connection with this.

I merely wanted to say that in the letter I tried to point out the basic justification for reactors at McMurdo, at the Byrd station and at the South Pole.

In our long discussion about atomic power, I think this is one area of the world where it meets all the criteria. No. 1, the economic costs are very substantial in providing power and heat in Antarctica. If the committee will refer to the letter, you will note that the cost at McMurdo, our base in Antarctica, is $1 to $3 a gallon for fuel oil, and at the pole and at Byrd station it is $7 to $10 a gallon.

I think the most significant thing of all, however, is that 80 percent, as I am informed, of all of our transportation to Antarctica, that is, air and ship, pertains to fuel oil.

So what we are striking at here is that 80 percent of our transportation to Antarctica. When we talk about transportation to Antarctica, I think it should be pointed out that it is a very difficult area to operate in. It is a very hazardous part of the world.

The weather problem, all of the elements that they must face in the support of activities down there, is quite apparent to anyone who has been down there.

I also want to say, Mr. Chairman, that I think it meets the second point, that is, it will add information to our civilian reactor program, especially in connection with the second round.

Third, international prestige. We have signed a treaty to be acted upon by the Senate, but which will be, I am sure, shortly, with 11 other countries for the peaceful development of the continent. I think that if the United States moved rapidly to provide power for these three stations, nuclear power, it would enhance our prestige in the area.

So when you consider all of the criteria that one would want to consider in this program, I think this is one area of the world where all the criteria is met and cannot be countered by argument. And I might add a fourth point, that I do not think there will be an argument of public versus private power.

I just wanted to make that brief summary statement of the letter. The details, the design and engineering, and the specific technical aspects of this effort I presume will be made available in a general way this morning by the Navy. I want to thank the Chair for the opportunity to make this short statement.

Representative HOLIFIELD. You may proceed, Admiral, and, if you will, tell us what the Navy's intentions are in this area.

Admiral CHEW. Mr. Chairman, I think I should go back a little bit and explain that the reason it was not included in the 1961 budget, money for nuclear power at Antarctica, the three stations, was purely the high initial cost.

From the point of view of the Chief of Naval Operations, you cannot do all things to all people. This was unquestionably a national prestige item, but from the point of view of military requirement it suffered in comparison with the more urgent operational needs.

I think I could unqualifiedly say that we would like to install nuclear plants at all three stations, and I would also say primarily that the first one, I should think, should be at the pole, if for no other reason than the prestige aspect of it.

So planningwise, we would expect that. As to the details of it, Captain Coxe can go on. But from the point of view of the Chief of Naval Operations, I am sure those would be the governing factors.

Representative HOLIFIELD. As I understand what you said the impact on your annual budget is the reason for not requesting this?

Admiral CHEW. That is correct, sir.

Representative HOLIFIELD. And notwithstanding the fact that studies show that the long-range cost of it would be less than the conventional plant?

Admiral CHEW. I would say one other thing in defense of this, sir. Of course, it would amortize itself very quickly, as Senator Jackson pointed out.

Representative HOLIFIELD. Will you give us some figures on the economics of this, Captain Coxe, as you go along?

Senator JACKSON. There is no question about the cost. It is about one-fourth of the cost of supporting a conventional operation.

Admiral CHEW. There is no question about that.

Senator JACKSON. We have to risk lives down there to provide heat and to provide electricity.

Admiral CHEW. Flying in the fuel and so forth.

Senator JACKSON. This is a pretty rough operation. Let us face it. I think that is lost sight of in looking at this picture.

Mr. Chairman, I just wanted to say that when fuel runs $7 to $10 a gallon, the argument over economic feasibility, I think, sort of goes out of the window. That is what it costs at the pole.

Admiral CHEW. I may be getting into an area that I am not too familiar with, but I think as far as the state of the art and a packaged deal, the timing possibly did not warrant the inclusion this year. I think maybe Captain Coxe can explain that a little better.

Senator JACKSON. I might add, too, that the Navy is in a difficult situation on this, Mr. Chairman, because this project is thrown in with all their other projects. The Navy is down there as an agent for our Government. It has the responsibility of providing the support in Antarctica.

We have as our primary objective in Antartica various scientific research projects that are carried out under the National Science Foundation. The Navy is providing the overall support to the area. I think it is unfair to force the Navy to get stuck with these items that really ought to be treated separately. They have to compete with each and every other item in the entire Navy budget.

Representative WESTLAND. I understand that these portable nuclear powerplants are now being built out at Sundance, Wyo., and this is just the type of unit that would be used at the pole or in the Antarctic.

I believe, Admiral Chew, you are not quite correct in the statement that the state of the art is behind. I believe it is at the present time ready to take care of that situation. That is my understanding.

Representative HOLIFIELD. That is the Martin Co.'s effort?

Colonel WILLIAMS. May I comment on that?

Representative HOLIFIELD. Yes.

Colonel WILLIAMS. The packaged plant, the portable prepackaged plant for the pole, would be what we call the PL series. This is a packaged version of our boiling water plant at Arco, Idaho. That is currently at 300 kilowatts electrical, but we think that system will go up to 800 or 1,000, which is what they need at the pole and the Byrd Station.

We believe that the state of the art would not permit a awarding a contract for that particular item until July of 1961. We need another year before we can prove out the core for that plant. This, then, would lead to a shipping date out of the United States by November of 1962 for installation and operation by February of 1963. This defines the state of the art proceeding under normal schedules.

Representative HOLIFIELD. You are taking into consideration the Army packaged plant and the work that is being done by the Martin Co.?

Colonel WILLIAMS. The Martin plant is a larger plant, around 1,500 kilowatts.

Representative HOLIFIELD. Is there any reason why it could not be reduced to 1,000 kilowatts?

Colonel WILLIAMS. It could be, but it would be unnecessarily expensive.

Representative HOLIFIELD. The cost?

Colonel WILLIAMS. The PM plant would be quite a bit more expensive, probably a million dollars more expensive than the smaller, low-power plant.

Senator JACKSON. I just want to ask this question: Is it not possible to move faster than that?

Colonel WILLIAMS. These are normal schedules. Yes, sir.

Senator JACKSON. I do not mean a crash program. But I do not see why we have to make an unusual project out of this. I would think it would be possible to move faster with the information that we have now, even if we do not handle it on a competitive bidding basis.

Colonel WILLIAMS. These small ones, sir, would not be competitive bidding.

Senator JACKSON. But you feel it would take until 3 years from now, roughly, before we could have one set up down there? That would be February of 1963.

Representative WESTLAND. The Chairman of the Atomic Energy Commission is here. He can speak to this matter.

Mr. MCCONE. Mr. Chairman, I think real progress can be made very fast. I would like Dr. Pittman, head of the Reactor Development Division, to give his views.

Dr. PITTMAN. Sir, I have not had a chance to review all of the details of the Kaiser study. But the water reactor technology that we

now have behind us and that we now know is such that I feel we could reasonably rapidly go forward on construction of the size plant being discussed here.

Chairman ANDERSON. When you say "reasonably rapidly," what do you mean—6 months or a year?

Dr. PITTMAN. I think, sir, the design of the plant to meet the McMurdo requirements, for example, the designers could get started within the next 4 or 5 months.

Senator JACKSON. The testimony here, Doctor, is that the design would not be ready for calling for bids or to let it out for construction until 1961, June of 1961. What can you do to cut back that date?

Dr. PITTMAN. May I say one thing?

Senator JACKSON. The pole station is indicated as being the No. 1 priority, I assume prestigewise, and we are talking about a 500- to 1,000-kilowatt plant, or around 800 kilowatts.

Dr. PITTMAN. I think if we went rather quickly into the conceptual design studies, it would be necessary to design the specific plant that you would put down there, and we would be in a position to put out an invitation for proposals prior to the mid-calendar-year 1961 period.

Representative HOSMER. May I ask a practical question?

The icecap is several hundred feet thick down there, but how about putting an installation of this size on it?

Admiral CHEW. The icecap is about 1,300 feet.

Senator JACKSON. It is 75 feet. The pole is an elevation of 9,070 feet, I believe.

Admiral CHEW. Byrd is 1,300. I am sorry.

Senator JACKSON. No. I may be corrected, but I believe at the Byrd station the ice is 10,000 feet deep.

Am I correct?

Dr. MOONEY. 5,000 above the sea level and 5,000 below the sea level.

Senator JACKSON. It is 10,000 feet.

Representative HOSMER. Irrespective of the depth, how about putting an installation of this size on ice?

Colonel WILLIAMS. We are planning on doing that.

Representative HOSMER. I know, but has anyone made any study of the practicability of it?

Colonel WILLIAMS. Yes, one of the Army field plants now being procured will be placed on an ice foundation.

Representative HOSMER. My question is have there been any studies made of it? Your answer was not to the question, but it indicates there must have been some studies.

Colonel WILLIAMS. Yes, sir.

Senator JACKSON. Dr. Mooney is here from the Antarctic Project Office and maybe he can answer.

STATEMENT OF DR. JAMES E. MOONEY, U.S. ANTARCTIC PROJECT OFFICE

Representative HOLIFIELD. Dr. Mooney, could you give us information? Could we set the Empire State Building on 2 miles of ice and sustain it, or is that out of your field?

Dr. MOONEY. I might say at the pole it is around 9,000 feet, and about 8,500 of that is ice. There is only about 500 feet of land beneath.

Senator JACKSON. You did not mean 500 feet of it was ice.

Dr. MOONEY. 500 feet of it is land and the rest is ice. The thickness of the ice does not matter. The problem which we are concerned with is the use of the reactor on a specific place on the ice.

I understand from the technical experts that it is feasible to install that regardless of whether it is McMurdo or whether it is 9,000 feet up at the pole.

Representative HOSMER. The ice will support it?

Dr. MOONEY. Yes.

Senator JACKSON. You can put it on the same kind of a thing you are putting the Guam thing on. You have 90 percent of all the ice in the world down there.

Captain COXE. In the first place, we have invested about $200,000 out of money, maintenance money, in a contract with the Combustion Engineering Corp. through the AEC for the packaging and the breaking down of a boiling water plant so that it can be flown in to either Byrd or to the pole station in a C–130.

So it will come in manageable units. It will also be necessary, we feel, a year before the unit gets there, to set foundations for it at the site. Then if our problem——

Chairman ANDERSON. Could you not be setting foundations while it was being designed and built?

Captain COXE. We are working on that now.

Chairman ANDERSON. So there will be no delay on that?

Captain COXE. No, sir; no delay.

Then if the settlement continues, it may be necessary to haul the thing out and put it in a new location and continue to use it. It is a portable unit.

Chairman ANDERSON. Does the statement of the AEC this morning that it can speed this up help you any with your problem? Could you be ready faster than you have indicated?

Captain COXE. Senator Anderson, our problem is only financial.

Senator JACKSON. We are assuming you would have funds. We would not expect you to go ahead without the money.

Captain COXE. We have no money.

Senator JACKSON. That is the purpose of this meeting today.

Captain COXE. We need $16 million.

Representative HOLIFIELD. When would you need it? If the AEC went ahead with the conceptual design and furnished it to us before the end of the year, let us say, or by early spring, when would you have to make your request in order to get it in a budget?

Captain COXE. If we put it in a Navy budget, sir; is that your question?

Representative HOLIFIELD. Yes.

Captain COXE. The first budget we could put it in would be in the 1962 budget.

Senator JACKSON. Let's dismiss this part of it right away.

Captain, you know this has such a low priority, with all the other Navy items, that to talk about next year's budget is to talk about a fiction. Do you not agree?

Captain COXE. I am inclined to agree.

Senator JACKSON. I just want to be helpful. I think you folks are in an impossible position, based upon the guidelines you get, to even talk about including this item in the regular way in the Navy budget.

It just happens that you are the agent for the President in the operation in Antarctica.

Actually, this item, Mr. Chairman, should probably be in the Antarctic project office as a separate item.

I think the reason why there has been this delay is that the Navy does have its other requirements it must meet, and this item, of necessity, has a very, very low priority, because it does not pertain directly to the Navy's military requirements.

Representative HOLIFIELD. All right; we will accept that statement from the Senator.

Can you give us some figures now on the sizes and the costs and the savings that might be involved in this?

Representative WESTLAND. I wanted to ask a question first.

How long will it take you before you get a break even on the savings in fuel costs?

Captain COXE. On the McMurdo Sound plant, there is a figure here indicating the crossover point is about 5 to 5½ years after installation.

Representative HOLIFIELD. Start in an orderly way. Give us the sizes of the plant you want, the estimated cost, the savings that would be involved in operation, and the amortization time.

Captain COXE. For the McMurdo Sound plant, we originally planned on a 1,500-kilowatt unit. We have recently received indications that this may be eventually doubled, in which case we would probably put two units down there, although that is not firm yet.

Chairman ANDERSON. You have me confused now. I thought the Kaiser study was 1,500?

Captain COXE. Yes, sir.

Chairman ANDERSON. And that was too big. You had to squeeze it down to 1,000.

Now you say the McMurdo plant ought to be 1,500?

Colonel WILLIAMS. May I comment on that?

Chairman ANDERSON. Yes, sir. You are the one who made the comment originally.

Colonel WILLIAMS. The Kaiser study for McMurdo Sound is based on an installed plant of 4,500 kilowatts, consisting of three of the PM–1-type plants.

This gives a firm power of 3,000 and an installed of 4,500. That is the basis of the Kaiser studies.

Chairman ANDERSON. And the Kaiser report indicates the break-even time on that is 4 years?

Colonel WILLIAMS. 4.9 years, sir.

Chairman ANDERSON. And it is about 1 year at the Pole; is it not?

Colonel WILLIAMS. This was not included in the original Kaiser study. We have been working up this information now, sir, on the Pole and the Byrd station.

Captain COXE. We have a tentative figure on the Byrd station which would indicate 2.2 years after installation.

Chairman ANDERSON. That is fairly rapid. It would seem to me that you might be able to get to one standard size that you can use in all of these areas and not have a study for each one.

Representative HOLIFIELD. Just multiply the units in relation to your need.

Chairman ANDERSON. If you have 200 tons of rock to move, you do not get a 2,000 unit or something to move that; you make the truck

go back and forth a few times. You can use several units of this and have the design over in a hurry; can you not?

Here sits the AEC ready to move. Here is a project you can pay back in 2 years, by your figures, and 4 years in another case.

It would certainly be advantageous and of some prestige to have these going down there, it would seem to me.

Why not try to get it done? If you have no money in your budget, maybe the AEC ought to have some money for this, because maybe this is in its line of activity, and working with the Antarctic project.

It certainly would demonstrate power. It would show that there are areas where power is pretty quickly economical if you can pay back a plant in 2.2 years.

Colonel WILLIAMS. The PM-type plant, at 1,500 kilowatts, would certainly do the task. You would be paying a premium for an initial cost.

Chairman ANDERSON. Why not move to get that plant going so you could have several built? It would be wonderful.

Representative HOLIFIELD. Before you start on questions, could you differentiate between the PL series at Arco and the PM plant of Martin? That is about 1,500 kilowatts?

Colonel WILLIAMS. Yes.

Representative HOLIFIELD. And your PL series would be what?

Colonel WILLIAMS. 800 to 1,000. That is what the Pole and Byrd need.

Representative HOLIFIELD. If you need additional, you can put another unit in; is that right?

Colonel WILLIAMS. Yes, sir.

Representative HOLIFIELD. What is the status of the PL series in relation to the PM? Which is in the advanced position now?

Colonel WILLIAMS. The PM is in the more advanced position. We could award a contract for that in July of this next summer and get delivery some 16 months later on; have it ready to ship in November 1961, and have that installed and operating by February 1962.

Representative HOLIFIELD. What is the cost of that?

Colonel WILLIAMS. One of those is about $4.5 million.

Representative HOLIFIELD. What about the PL?

Colonel WILLIAMS. The PL? We find that we have to do considerable new core development on that plant.

Representative HOLIFIELD. So you are not ready to work with it?

Colonel WILLIAMS. Well, from a conservative approach, we would say that would come in a year later. We would be ready to contract for that one in July of 1961. We would ship it out of the continental United States in November of 1962, and have it operating by February of 1963.

Representative HOLIFIELD. Have you an estimate as to what that would cost?

Colonel WILLIAMS. That would cost about $3.5 million.

Representative HOLIFIELD. But you would also have a smaller plant?

Colonel WILLIAMS. Yes, sir.

Representative HOLIFIELD. So costwise it is about the same, that is, in relation to capacity?

Colonel WILLIAMS. Right.

Captain COXE. Mr. Chairman, may I comment on his remarks first before the presentation?

Representative HOLIFIELD. Yes.

Captain COXE. We are very much more interested in the PL, the boiling-water plant at this time, from a practical and operational point of view, in that the operating crew for the PL plant, as I understand it, is only about half the size of the crew for the PM.

Also, the number of packages which you will have to take all the way down to Antarctica and then fly to the site is considerably less for the PL than for the PM.

So from an operational point of view, that looks like a much more satisfactory plant.

Of course, we have to have security of operation, I mean, we cannot do test work at the Antarctic.

To get back to the McMurdo plant at the moment, we are planning on 2 plants of 1,500 kilowatts each. They will cost, including installation charges and other related charges, beside the cost of the plant, itself, roughly $4.5 million apiece.

At the Pole station, we are planning an 800 to 1,000 kilowatt PL plant.

Representative HOLIFIELD. That is the Byrd site?

Captain COXE. Pole and Byrd are the same.

Representative HOLIFIELD. What sizes did you say?

Captain COXE. That is the 800 to 1,000 kilowatt range. The cost of that is somewhat in excess of $3.5 million, $3.5 million for the plant and maybe a half million for the site installation and preparation which would make it $4 million for each of Byrd and the Pole.

Representative HOLIFIELD. Would one unit of that size take care of your needs there?

Captain COXE. Yes, sir.

In all of these cases we are planning on a diesel backup. In most cases the diesels are already there, but we have to have some backup.

The problem of timing on this thing is still a little difficult because of the very short construction season that they have.

For instance, if they can build one of these units in 14 months as contrasted with 18 months, this whole program could be moved up a year.

Representative DURHAM. When was the Navy assigned this responsibility?

Admiral CHEW. I think it was 2 years ago, in the Deep Freeze operation for the Geophysical Year.

Representative DURHAM. Two years ago?

Admiral CHEW. Yes, sir.

Captain COXE. 1958.

Senator JACKSON. The Navy has had the support operation in the Antarctic from the very beginning?

Admiral CHEW. That is right, sir, from the very beginning of Deep Freeze I. That was 1953–54.

Representative DURHAM. And you requested no funds, except diesel engine funds, to take care of that temporarily?

Captain COXE. So far as that is what we have; yes, sir. We did have an item in the 1961 operation and maintenance budget for the

McMurdo and Pole, and I believe, Byrd, too, which was eliminated in the course of budgetary review.

So we have no money in 1961.

Mr. RAMEY. How much money did you have in?

Representative DURHAM. Was it in the authorization act last year, or this year?

Captain COXE. No, sir.

To answer your question, we had about $7½ million, total.

Admiral CHEW. It fell out in competition with the operational requirements that Senator Jackson spoke of.

Representative DURHAM. Not at your level, but at another level in the Pentagon?

Admiral CHEW. Right in the Navy, in competition with other operational requirements of the Navy.

Senator JACKSON. Mr. Chairman, what we are witnessing here today is a classic example of poor budgetary procedures. There is no reason in the world why this should be a part of the Navy budget.

You agree with that, Admiral?

Admiral CHEW. I agree with that, sir.

Senator JACKSON. This is an example, again, where we are indulging in false economy. The fact that we could pay for this in a little over 2 years, I believe, at the Pole, shows the real economy of it.

Then when you consider international prestige, I think the finest thing we can do in ratifying the treaty with the 12 countries down there, for peaceful development, is to take the initiative and put these projects in.

This, of course, Mr. Chairman, does not include the fact that we will be removing an substantial percentage of the hazard in operating in Antarctica.

This, to me, is a matter that you cannot, we all agree, measure in dollars. But we have lost many lives.

Representative HOLIFIELD. The crash of one big transport plane would pay for this, almost, not to mention the savings in lives.

Senator JACKSON. These men are doing an outstanding job down there under difficult circumstances. They do not have the benefit of all of the weather information you have in other parts of the world. They have to contend with impossible situations.

As I pointed out here, and I emphasize, information given to me this morning is to the effect that 80 percent of all the transportation requirements in Antarctica bear on what we are talking about this morning, to provide petroleum to support electric power and heat requirements.

By installation of atomic power plants, we will virtually remove that 80 percent load.

Chairman ANDERSON. Admiral, I wonder if this is not a proper question: this is a business management problem, primarily.

The Chairman of the Atomic Energy Commission made a pretty fair reputation of a businessman. What would be wrong with asking the Atomic Energy Commission to go ahead and see what they could do about one plant at the Pole station, one or maybe two at McMurdo, three plants finally at McMurdo, and one plant at Byrd, even if they were all of the same size?

Suppose you only needed 1,000 kilowatts at the Pole station, but it is going to pay for itself in 2 years, if you had 1,500 it would pay for itself in 3 years, if you are only using 1,000.

That is pretty good business. If you built the same plant and built five copies of it, you would be able to solve this problem pretty quickly.

What would be wrong with building different copies? Why not ask the Atomic Energy Commission?

You say, and we are not being critical, that it is not the place to have it in your budget, because it is really another operation.

Mr. McCone, would you mind commenting on that. It would seem to me that here the Atomic Energy Commission could do all the services a great service by getting this little plant underway promptly and letting them use two or three units if they had to.

STATEMENTS OF JOHN A. McCONE, CHAIRMAN; GEN. A. R. LUEDECKE, GENERAL MANAGER; DR. FRANK K. PITTMAN, DIRECTOR, DIVISION OF REACTOR DEVELOPMENT; DON S. BURROWS, CONTROLLER, DIVISION OF FINANCE; FRANCIS J. McCARTHY, ASSISTANT CONTROLLER FOR BUDGETS, DIVISION OF FINANCE; ALGIE A. WELLS, DIRECTOR, DIVISION OF INTERNATIONAL AFFAIRS; ANGELO GIAMBUSSO, CHIEF, WATER REACTORS BRANCH, DIVISION OF REACTOR DEVELOPMENT; AND JOSEPH HENNESSEY, COUNSEL, DIVISION OF REACTOR DEVELOPMENT, ATOMIC ENERGY COMMISSION

Mr. McCone. Yes, I would like to comment on that.

In the first place, I would like to bring to the attention of the committee that one thing we want in this area, if we are going to put nuclear plants, is the greatest dependability.

I think at this point in the development of these small plants, the greatest dependability will come from pressurized water. That has the background of submarine experience, Fort Belvoir, Shippingport, and all the other effort that this committee is familiar with.

Furthermore, it does not seem to me, with this prospect of development, that there is very much of an issue to whether you have 1,000 kilowatts or 1,500.

You do need these plants as in multiple plants, because you do have to have backup, you do have to replace cores.

Therefore, you have to have reserve power. One thing that appeals to me as I listen to this discussion is that the producing of these plants in multiple units will reduce it by some order of magnitude.

The exact amount would have to be developed, but it has been my experience in other areas that when you get 5 or 10 like units you sometimes run into very unexpected savings in quantity production.

Finally, with respect to operations, while theoretically it may take less of a force to operate a 1,000-kilowatt boiling water reactor than a 1,500-kilowatt pressurized water reactor, this is highly theroetical.

We do not know the manning table of these small boiling water reactors. It is our opinion that at this stage of development we cannot very accurately forecast the exact complement of operating

personnel. Therefore, under present procedure this is strictly a matter for those who are in charge of the area to make up their minds what they want.

As far as the Atomic Energy Commission is concerned, we are prepared to support their requirements immediately and just as expeditiously as possible; with respect to the pressurized water, the 1,500-megawatt plant, we could, as the colonel has said, contract this out in mid-1960 or soon after the money becomes available, and it would not take very long to be ready to ship.

The boiling water reactors would be a little later. But I am rather optimistic that if there is a real need that we can move such developmental work as remains to be done ahead with great rapidity.

Representative HOLIFIELD. I think that is a fine statement, and I agree with you in your logic that the type of a plant that is built there should be the plant that would be the most dependable as a result of our developed technology.

We would not want to have a plant there that we were experimenting with as far as its continuity of operation is concerned.

Chairman ANDERSON. Would it be possible to ask the Atomic Energy Commission when they come back in April to see whether they can give us some sort of an outline of this type of procedure?

I hope, Mr. CcCone, when you come back in April for the second part of the authorization hearings, you might include an item of that nature. I realize the Budget Bureau requirements exist. But you might give us an item, and you are allowed to do that upon request, which we might consider for insertion into the authorization bill.

Mr. MCCONE. You know, we are developing these plants. But the using agencies are really responsible for budgeting. I do not know whether we can extend our responsibility of developing into a demonstration of the type envisaged here. But you are asking us to go a little further than our normal responsibilities.

Senator JACKSON. Mr. Chairman, might I ask that the appropriate agencies here, the Navy and the U.S. Antarctic projects officer, draw up at our request a bill of particulars as to what is needed, and a descriptive picture of the situation, and present it to the Atomic Energy Commission at our request?

(The material referred to follows:)

WASHINGTON, D.C., *March 14, 1960.*

From: U.S. Antarctic projects officer.
To: Hon. Chet Holifield, Member of Congress, Chairman, Subcommittee on Legislation, Joint Committee on Atomic Energy.
Subject: Nuclear powerplants in Antarctica.

As requested by your committee, the following is offered covering nuclear powerplants in Antarctica:

As you are aware, the U.S. Government through some of its agencies, is conducting extensive operations in the Antarctic. With the recent Antarctic treaty, as approved by representatives of the participating nations, we fully expect the U.S. operations in the Antarctic to continue into the foreseeable future. Accordingly, it has become necessary for us to plan for supporting these operations on a basis consistent with long-term occupancy rather than the adequate-for-survival and minium operational basis followed heretofore. Inasmuch as the Department of the Navy has been delegated responsibility for the logistic and operational support of the U.S. Antarctic efforts, they are vitally concerned with meeting the problems of enlarging the support capability as economically and efficiently as possible. Since electricity is the most practical and the safest means of distributing energy in the Antarctic environment, the Navy will require a substantial increase in power generation capacity.

Because of the difficulty and uneconomical means now necessarily employed in furnishing supplies and materials to these remote and relatively inaccessible Antarctic stations, it has been determined that nuclear power is the most practical and economical means of providing the electric power required to support these operations.

Several recent studies conducted by various organizations confirm that substantial savings in money and manpower will be realized when nuclear power is utilized to the maximum extent in the Antarctic. Through our established liaison channels, we are following with keen interest the work of the Atomic Energy Commission in developing prepackaged, easily installed nuclear powerplants in the smaller power ranges. We believe that consideration of such types of nuclear powerplants for the Antarctic is consistent with the programs already underway in the Commission, particularly since the economics of nuclear power are being proven attractive.

Some typical cost and handling problems incidental to fuel deliveries to the pole and Byrd stations are worth noting: Diesel fuel costing over $1.50 per gallon at McMurdo is flown from McMurdo and parachuted in 50-gallon drums, 4 drums per drop pallet, 18 pallets per aircraft load. Each drum costs $7.10; each pallet costs $139.28; each parachute costs $56.25. These costs alone add up to over $4,000 per planeload, and none of the drop equipment is reusable. Another factor is that 6,000 gallons of aviation gas are consumed in delivering 3,600 gallons of diesel fuel, and not all of that is recoverable. Another important factor on which no dollar value can be placed is the hazard to human life in these aircraft operations. There are additional expenses common to all the Antarctic installations, such as material handling, hourly cost of aircraft, initial delivery of materials to McMurdo, which make them, no doubt, the highest cost power areas in the world.

In view of the Atomic Energy Commission's known interest in achieving and demonstrating the economical use of nuclear power, we suggest that the Commission undertake to provide appropriate nuclear powerplants specifically for use at McMurdo Sound, the pole station, and the Byrd station in Antarctica. After installation and initial operation, the continued operation, it is assumed, would be carried on by trained naval personnel now available. Such an undertaking would, in our opinion, serve the best interests of the Government. As you know, there is a great interest in the world at large, in the activities being conducted in the Antarctic. Accordingly, undertaking such a project would undoubtedly be viewed as a bold step in advancing the position of the United States and accomplishing, in the most economical manner, that which we are obliged to do at any rate.

The estimated power requirements are as follows:

McMurdo Sound station, 3.0 and 4.5 MWE operating by March 1963;
Byrd station, 0.8 MWE operating by February 1964;
Pole station, 0.5 MWE operating by February 1963.

If, in the opinion of all concerned, standardization appears more practical, we feel sure no one would have any objection to having identical nuclear plants at all installations, regardless of the requirement set forth. It would appear from consultations with various representatives of the military services, and representatives of the Atomic Energy Commission, that the pressurized water, nuclear plant is presently the most advanced in technology and also the most reliable. This was borne out in the statement made by the Honorable John A. McCone, Chairman of the Atomic Energy Commission, before the committee on Friday, March 11. Furthermore, this type plant has been completely designed and fabricated, and many members of both the military and civilian agencies have been invited to observe such a plant at Dunkirk, N.Y., on the 29th of this month.

The long-continued interest of your committee in demonstrating the feasibility of nuclear powerplants in isolated areas is a matter of record. Your support in installing such plants in the Antarctic would be a striking demonstration of their practicablity and we feel certain, would reflect most favorable upon the prestige and work of your committee.

Sincerely,

DAVID M. TYREE.
JAMES E. MOONEY, *Deputy.*

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Senator JACKSON. Then when Mr. McCone comes in in April the committee will have all the information necessary and essential to consider these items in the authorization bill if we so decide at that time.

I put it this way because these items are not in the budget. I would like the Chair to make that request ofthe appropriate agencies.

Representative HOLIFIELD. The request is made as Senator Jackson has outlined.

I might say that in this day of taking from one pocket and putting into the other, you might also think a little bit about recompensing the AEC out of your annual costs which this would obviate.

In other words, if it is costing you $2 million a year to carry this fuel up there, let us have an arrangement like the Department of the Interior has with the AEC on the $4 million experimental low-temperature process heat reactor. Let us have some business arrangements.

Senator JACKSON. On that point, somebody in turn ought to reimburse the Navy for this undertaking that they are engaged in that is completely outside of their day-to-day naval requirements.

Admiral CHEW. Thank you, sir, very much.

Senator JACKSON. I want to say that Admiral Tyree and the Navy people, and the Air Force—that is, MATS—that has provided a heavy transport support with C–124's, primarily, and now I believe the Navy and the Air Force are providing with C–130's, have done a fantastic job in that area.

Representative HOLIFIELD. How about a lend-lease arrangement between the AEC and the Navy, Mr. McCone? In these days of the popularity of lend-lease, I do not see why we could not utilize that.

Representative HOSMER. Maybe Mr. McCone could just sell them the power down there.

Representative HOLIFIELD. Mr. McCone, I just said how about a lend-lease arrangement between the AEC and the Navy and amortize the cost of this plant out of their annual maintenance. You might trade them some atomic kilowatts for some of this $7-a-gallon oil.

Mr. MCCONE. Mr. Chairman, I will take Admiral Rickover's privilege of telling a story about a young mother who took her two boys, ages 8 and 10, abroad an aircraft carrier to see their father who was the captain of the carrier. They were met at the foot of the gangplank by an orderly, and then the executive officer greeted them, and finally they went into the captain's quarters. They were served a delicious lunch, with nice service.

They left and then there was a similar ceremony, only in reverse. As they walked down the dock, the little boy looked up to mother and said, "Mother, why is daddy so rich and we are so poor?"

So as far as the AEC is concerned, "daddy is so rich but we are so poor."

Representative HOLIFIELD. I think that is a very pertinent story.

Are there any further questions on this, Senator Jackson?

Senator JACKSON. No.

Representative HOLIFIELD. Did you finish, Captain?

Captain COXE. I gave all the essential information, sir.

Senator JACKSON. I would just hope that we would have all this data by the April meeting, to cover all three stations. The committee members would then be in a position, Mr. Chairman, to decide what

they wanted to do, but to have it just as if it were being presented and had a budget approval. The only thing is we are requesting this.

Representative HOLIFIELD. If there are no further questions, we thank you for your presence, gentlemen.

We will ask the AEC to come forward at this time.

Admiral Chew, to complete your testimony, will you please furnish to this committee the number of planes that have been lost or which have crashed in servicing these Antarctic bases and the number of casualties you have had?

Admiral CHEW. Yes, sir; I will.

Representative HOLIFIELD. And an estimation on the cost of the planes and equipment that were involved.

Admiral CHEW. Yes, sir.

Representative HOLIFIELD. Thank you.

(The information referred to follows:)

LOSSES IN SERVICING ANTARCTIC BASES

Since the start of Operation Deep Freeze I through Deep Freeze V, 17 lives have been lost. This includes those lost in aircraft crashes and other logistic operations, such as with tractors, weasels, and snowmobiles. There have been 17 aircraft lost. Fifteen were Navy aircraft at a total cost of $5,373,000. This includes one P2V at a cost of $1,400,000. Two Air Force C–124's were lost that cost a total of $5 million. Ground mobile equipment losses were eight tractors costing $32,000, three weasels costing $42,000, and two snowmobiles costing $34,000.

In summary, 17 lives were lost, 17 aircraft, and 13 ground vehicles were lost. The aircraft and ground vehicles cost $10,481,000.

(The following document was also received for the record:)

APRIL 6, 1960.

Memorandum for the record.

Subject: Loss of life and equipment—Antarctic Operations, Deep Freeze 1 to 60.

During the hearing before the Joint Committee on Atomic Energy, Subcommittee on Legislation, chaired by Congressman Holifield—continued testimony on S. 3084 and H.R. 10656 (bills to authorize appropriations for the Atomic Energy Commission for fiscal year 1961)—I discussed with the chairman the fact that there were certain losses of life and equipment during the support operations in Antarctica. As a result of this discussion, Senator Jackson, Congressman Holifield, and I discussed the advisability of entering facts in the testimony which would show such losses. As a result of our conversation, the chairman asked to have the above information furnished the committee, by the Navy, to be used as part of the testimony.

This office was asked to secure such information. It was secured and furnished to Captain Schaffer. The verification of the information furnished was received from Captain Munson, commander, VX–6. The information furnished is as follows:

U.S. NAVY LOSSES

Aircraft stricken:

11 (different classes).
2 for overage, not economically feasible to return to CONUS.
2 helicopters.
Total estimated value of aircraft $5,373,000

U.S. AIR FORCE LOSSES

2 C–124 Globemasters, at $2,500,000 each $5,000,000
2 other C–124 (had nose failure landing on ice runway).
(No costs of repair figures available.)

ROLLING STOCK LOSSES

8 tractors, at $40,000 each, total loss	$320,000
3 vessels, at $14,000 each, total loss	42,000
2 snowmobiles, at $17,000 each, total loss	34,000
Total	396,000
Grand total	10,779,000

JAMES F. MOONEY, *Deputy.*

COOPERATION WITH THE GOVERNMENT OF CANADA

Representative HOLIFIELD. Now, gentlemen, we will take the Canadian cooperation item, section 110.

Mr. LUEDECKE. Mr. Chairman, section 110 of the proposed bill requests authorization in accordance with the provisions of section 261(a)(2) of the Atomic Energy Act for $5 million for use in a cooperative program for research and development in connection with heavy water moderated powerplants to be conducted under the agreement for cooperation concerning civil uses of atomic energy between the Government of the United States and the Government of Canada, which was signed on the 15th day of June 1955, as now or hereafter modified.

This would permit a very much closer integration of our joint effort with Canada and our activities under the agreement with Canada in the heavy water moderated natural uranium reactor field.

Pursuant to the agreement, we have worked out in draft with the AECL of Canada a memorandum of understanding which would be an implementing action of the agreement which would spell out the details of this particular cooperative program. It will necessitate submitting to the committee an amendment to the agreement.

Mr. Wells is prepared to cover the details of the agreement or of the program.

Representative HOLIFIELD. Mr. Wells, do you want to give use the details?

Mr. WELLS. Thank you, Mr. Chairman.

First of all, let me amplify what General Luedecke said, that if we reach final agreement with Canada, then we will bring to the committee an amendment to the existing agreement for cooperation with Canada, which, among other things, would extend the term of the present agreement.

The present agreement expires in 1965. It might provide for the possibility of lease of heavy water. This has not been decided yet. Canada has not finally requested it. They suggested that they might.

It would also involve modification of the patent provisions. Then the second paper that we have been talking about is the detailed understanding between us and Canada—just how the cooperation relating to these reactors would take place.

As the committee knows, after we negotiate an agreement for cooperation, we enter from time to time into detailed understandings with respect to certain phases of it. This agreement would call for an exchange of information, an exchange of personnel over a period of 5 years, after the Canada reactor comes into operation.

I think at this point, if I may suggest, Mr. Chairman, Dr. Pittman might like to add the details as to the technical exchange.

Representative HOLIFIELD. Dr. Pittman.

Dr. PITTMAN. In the technical exchange that we are speaking of in this request for authorization, what we have in mind is that we participate by actually carrying out research and development programs in this country specifically aimed at the large 200-megawatt reactor and also to the extent possible to the smaller, 20-megawatt NPD reactor.

If the Canadians go ahead with their organic cooled heavy water moderated experimental reactor, we would participate under this cooperative program with them in that venture. The latter is not a program that has been definitely decided on.

The type of work that would be involved under this agreement would be engineering development work that we in this country and our contractors and our laboratories can do most rapidly and best, and that the Canadians on the other hand might be somewhat weaker on. For example, one of the major new developments that the CANDU reactor hopes to incorporate is the development of a continuous loading and unloading device which, if it can be made to work out, will make it possible to increase the exposure time of the fuel, the natural uranium fuel that is going to be used in the CANDU reactor.

We and the Canadians feel that we can be quite helpful, and that the program carried out in this country could contribute quite a bit to such a development because of the special talents of people in this country.

That is one of the types of things that we would do. We would also carry out work on other experiments for the Canadian reactor that would be useful to them from our facility at Savannah River. The program that we would be carrying out—well, I will give you another example of the type of thing that we would do.

The fabrication of zirconium tubing to be used in the CANDU reactor and the connection of this tubing to the stainless steel parts that will be outside the reactor is something that we can do quite usefully toward the CANDU reactor. It fits into some of our other programs in this country also where we are trying to work out fabrication techniques for zirconium tubing and the connection to stainless steel.

Representative HOLIFIELD. It is this type of work that the $5 million would be spent for in our laboratories?

Dr. PITTMAN. It is the general type. If you want to go into more detail, we have a gentleman who has just returned from a meeting with the Canadians, who discussed with them some of the details going into this project, but generally it is the type of engineering development that can be specifically applied to the CANDU reactor. This, of course, is in addition to the program we will be carrying on in this country that is aimed at our own four reactors that we have under development in the heavy water field.

Representative HOLIFIELD. Would the majority of this $5 million be spent in our national laboratories?

Dr. PITTMAN. I do not know that I can give you a breakdown. Certainly some of this money will be spent in the national laboratories, but we are also proposing that some of this will be spent in particularly industrial laboratories.

Representative HOLIFIELD. Private contracts?

Dr. PITTMAN. Yes.

Representative HOLIFIELD. But in this country rather than in Canada?

Dr. PITTMAN. It is proposed that this be spent entirely in this country; yes, sir.

Representative HOLIFIELD. What about the starting and finishing of the CANDU project? Can you give us their schedule?

Mr. GIAMBUSSO. The Canadians have started the CANDU reactor design. They estimate they will complete the reactor and have it in operation by late 1964 or early 1965.

Dr. PITTMAN. This is for the 200-megawatt reactor. The NPD is already underway and should be completed by early 1961.

Representative HOLIFIELD. Is this a prototype for the CANDU?

Dr. PITTMAN. NPD is a 20-megawatt prototype of that; yes, sir. It is a prototype reactor. The decision on the other type that I mentioned, the organic fuel, will not be made until more experimental work in analysis has been made.

They are working with us now on that. People from AI and from our laboratories are working with them on the analysis and on the potential experimental programs that will be carried out under the program.

Representative WESTLAND. Do I understand, Doctor, you have four other similar programs going on in this country now?

Dr. PITTMAN. There are four reactors in this country, all of which we consider as part of our heavy water reactor program. There is the heavy water component test facilities reactor down at Savannah River, which was authorized and which is under construction for the purpose of developing heavy water component parts for use in heavy water reactors.

There is the plutonium test reactor at Hanford, the purpose of which is to develop the plutonium recycle activities for the Commission, but it is also a heavy water moderated cooled reactor, so the technology from that reactor will also be applicable to this program.

The other reactor that is under construction is the Carolina-Virginia heavy water moderated cooled reactor, a 17-megawatt reactor, which is a prototype for a larger reactor. That reactor is under a cooperative program.

The final one is the Florida gas-cooled, heavy water moderated reactor, which the Florida people are developing now. The determination has not yet been made to go forward with the construction of that reactor.

Representative VAN ZANDT. Doctor, is this the initial and only joint working arrangement of this type we have with a foreign country?

Dr. PITTMAN. No, sir. We have been working, as you know—I would rather Mr. Wells explain this—with the Canadians for quite a while, even in this heavy water program.

The reason for the specific request for authorization is because we will be putting our funds into a project that is specifically aimed at the Canadian project itself.

Representative VAN ZANDT. In other words, this is similar to the EURATOM program?

Mr. WELLS. Mr. Van Zandt, it has some characteristics in general similar to EURATOM.

Representative HOLIFIELD. It is bilateral with Canada.

Mr. WELLS. Yes, sir. I believe this will be the first case in which we will have what I would call a joint venture, putting in some money with another country. We have been exchanging information with Canada for many years in various fields.

Representative VAN ZANDT. If we were to take on this CANDU project ourselves, what would it cost us in round figures?

Dr. PITTMAN. We have estimated that this construction of this reactor, or a reactor of this general type, heavy water moderated and cooled in the 200-megawatt range, would be in the range of $55 million to $60 million.

Mr. Giambusso can give better figures.

Mr. GIAMBUSSO. I would like to quote the Canadian figures. At present they include $60 million for construction and $20 million for design and development.

Our estimate of a plant would run approximately $75 to $80 million.

Representative VAN ZANDT. $75 to $80 million?

Mr. GIAMBUSSO. Yes.

Representative VAN ZANDT. This $5 million, is that the initial contribution toward this project?

Mr. GIAMBUSSO. Toward the specific project; yes, sir.

Representative VAN ZANDT. Should we anticipate there will be additional sums requested in following fiscal years?

Mr. GIAMBUSSO. This $5 million is the extent of our participation. We can now foresee that expenditure of these funds will occur in the next few years. We are asking for $5 million and this is the program.

In the event that as a result of these expenditures or changes in the program it becomes reasonable to go forward with another program, that would be subject to subsequent authorization.

Mr. VAN ZANDT. The way it looks at the moment, then, for $5 million we will enjoy not only the benefits of experience obtained as we work with the Canadians jointly, but when the project is complete we will enjoy the benefits from this type of an operating reactor?

Mr. GIAMBUSSO. The $5 million that we would be putting into this project will allow us to get all of the information from the design, construction, and operation of this 200-megawatt reactor that is being built. It is the type of reactor which, if we were to build, we would build.

Representative VAN ZANDT. Will we be asked by the Canadians to appropriate any money for the operation of this reactor when it is complete?

Mr. GIAMBUSSO. No, sir.

Representative VAN ZANDT. In other words, barring additional requests that may necessarily have to come in the way of appropriations, for $5 million we are going to get the benefits, we will say, of about a $75 million reactor?

Mr. GIAMBUSSO. We are getting the benefits of not only the construction, the operation, and construction of this reactor, but the research and development going into this reactor, as well as the NPD reactor that precedes it.

Representative BATES. If the Canadians had not gone ahead with this, would it have been your intention to recommend this type of thing for us to pursue?

Dr. PITTMAN. Sir, I think on the basis of the way I like to approach any reactor problem, or the construction of any concept to its ultimate, had the Canadians not had such a program I would not have wanted to step right into the construction of a large-scale reactor until we had information from the four reactors which we now have under construction to a point where we would know better whether we needed an intermediate prototype.

In this particular area, where we are just using normal uranium, we cannot talk prototypes quite as small as the prototypes we have talked about in the past from enriched uranium.

To get the full benefits of the prototype, it has to be somewhat larger.

What I am saying is that the reactor that would have been built if we had not been looking forward to working with the Canadians in the immediate future might not have been of the same size, but would have been somewhat smaller.

Representative BATES. But you would have embarked upon a certain type anyway, a certain size?

Dr. PITTMAN. Yes. My recommendation would have been to look into the information being developed from our present program and at such point as it meets the criterion established for the construction of prototypes, we would request the authorization for construction of a prototype of a size that would be necessary to get the information that we need.

Representative BATES. But that size would cost us more than it would cost us here?

Dr. PITTMAN. Certainly more than $5 million. That would correspond roughly to the $55 million figure that we estimated.

Representative VAN ZANDT. Mr. Chairman, the AEC submitted to the Bureau of the Budget a figure of $55 million to build a heavy water, natural uranium reactor.

It was deleted by the Bureau of the Budget.

Are we to understand that this joint project we have with the Canadians is sufficient to provide us the necessary knowledge we must have to build this type of reactor?

Dr. PITTMAN. In my opinion, this is right; sir, yes.

Mr. MCCONE. Can I just make one remark?

Representative HOLIFIELD. Yes.

Mr. MCCONE. That figure was not deleted by the Bureau of the Budget. The $55 million was submitted to the Bureau of the Budget in a preliminary estimate, and that was deleted by the Commission, itself, after it became clear that this cooperative arrangement could be made.

Representative VAN ZANDT. In other words, the AEC withdraw it?

Mr. MCCONE. Yes. Had we not succeeded in developing this cooperative arrangement in a satisfactory way, I believe, while I cannot speak for all of the Commissioners, our attitude would have been to leave the $55 million in there, and I think we could have successfully defended that before the Bureau of the Budget.

Representative HOLIFIELD. This NPD 20-megawatt reactor is now being built; is it not?

Dr. PITTMAN. Yes, sir.

Representative HOLIFIELD. And the one that you envisaged was about 50,000 kilowatts, was it, or 60,000?

Dr. PITTMAN. We had never carried it far enough to make an exact determination of what the size would be. I think it would probably have been in the range of 50 to 75 megawatts, the one we had originally presented to the Budget as an alternative.

Representative HOLIFIELD. Do you think this kind of project is going ahead rapidly enough, not to leave us with a gap in this particular field?

Dr. PITTMAN. I think so; yes, sir.

Representative HOLIFIELD. That is 4 or 5 years?

Dr. PITTMAN. I think it is going ahead when you take into consideration the fact that the NPD is already under construction and will be in operation shortly, and information will be coming from that.

The construction of CANDU is on a reasonable schedule for the type of reactor and the size reactor that is being built.

I think there will be no gaps in the time element and in our information.

Representative HOLIFIELD. There will be a frank and free exchange of all heavy-water technology between the United States and Canada in this field?

Dr. PITTMAN. That is right.

Representative HOLIFIELD. Mr. Wells mentioned something about the patent arrangements. What did you refer to there, without going into too much detail?

Mr. WELLS. Mr. Chairman, we are negotiating a Canadian patent arrangement which will, in effect, give us the same rights to inventions and discoveries as if these inventions and discoveries had been made in the United States.

I might say to summarize that, both parties have approached that with the point of view of putting each other in the same position, as if they had completely reciprocal rights.

Representative HOLIFIELD. That is certainly equitable.

Mr. RAMEY. It is different from the British operation?

Mr. WELLS. As I said, it is the first integrated joint venture and the best patent provision we have had.

Mr. MCCONE. This extends also to drawings, specification, and designs.

Representative HOLIFIELD. They have access to all of our heavy-water reactors that we have, such as the plutonium reactors.

Dr. PITTMAN. The agreement encompasses the four reactors that I mentioned on our side, and the information being developed for them and from them.

Representative HOLIFIELD. That seems like a mutually advantageous relation for both nations.

Dr. PITTMAN. I think in addition to just the construction of the reactor we are getting some technology and knowledge of people whose major effort has been in this field for quite a while. This is going to be quite good.

Representative HOLIFIELD. They have been a little ahead, I think, in this. They have specialized in the field of heavy water.

Dr. PITTMAN. Yes, sir.

Mr. MCCONE. I think it might be well, Mr. Chairman, if you will permit me, to have the record show that there is a reason for the Canadians to pursue this particular type of reactor development.

They have large resources of uranium, and they have no enrichment facilities.

Therefore, the hope of their uranium industry is in the development of natural uranium reactors or their alternative is to go to the enormous cost of developing an enrichment facility.

I think it is for that reason that the Canadian Government is willing to support this particular reactor design above all others.

Representative HOLIFIELD. The chairman may recall that I made a trip up to Canada in January on a speaking engagement before the conference of the governmental people and the mining people up there. I can say that they were very enthusiastic about this particular project, and apparently are entering into it in good faith and with full spirit to accomplish it.

Mr. MCCONE. Might I say, sir, your speech has been very helpful to us in our work with the Canadians.

Mr. LUEDECKE. Mr. Chairman, I think possibly one other point should be clarified with respect to the $5 million. This is for research and development and would not include the heavy water or use charges should they elect to ask.

Representative HOLIFIELD. If they elect to ask for that, approximately how much inventory value will be involved in the heavy water?

Dr. PITTMAN. For CANDU, it would be $14 million worth of heavy water, and for NPD $4½ million.

Total number of pounds is 500,000 for the CANDU and 610,000 for the NPD.

The use charge on those two figures are $560,000 a year for the CANDU, and $180,000 for the NPD.

Representative HOLIFIELD. In other words, they will get this on the same basis of lease rental?

Dr. PITTMAN. That is what this was calculated on.

Representative HOLIFIELD. That is the same as we use here domestically.

Dr. PITTMAN. This was calculated on a 4 percent use charge; yes, sir.

Mr. MCCONE. That is not firmly set forth in the agreement. The terms by which the heavy water will be furnished will be a matter of negotiation.

They may purchase it or it may be lent to them, for that matter. But that has not been decided.

Mr. WELLS. That is correct, Mr. McCone.

Mr. Chairman, may I suggest that the record may show that Canada has not indicated to us finally that they want this kind of an arrangement. We are mentioning it to this committee now so that you will be fully informed of all the possibilities.

Should there be a request for an arrangement on heavy water which the Commission deems advisable, it will be brought to you with a request for incorporation when all the aspects could be disclosed to you.

Representative HOLIFIELD. They are specialists in the production of heavy water.

Mr. TOLL. Since this is an authorization under section 261, wouldn't this section have to be amended to use the language "for use in a program" not to exceed the incremental amount of the value of the waiver of heavy water, in order for the use charge to be waived?

You might want to think about that.

Mr. WELLS. I am not a specialist on 261(a).

Mr. HENNESSEY. We are not asking at this time for any authorization of waiver of heavy-water charges. The understanding is that if we were to agree with Canada on some kind of use arrangement by which the use charges would be waived, we would come back for authorization from this committee.

Mr. TOLL. Then it might be advisable to firm that point up by April, if possible, so that if the language of this bill had to be changed, the committee would have the information by April in order to consider it.

Mr. WELLS. We appreciate that suggestion.

Representative HOLIFIELD. Is there anything further on this?

Mr. LUEDECKE. No, sir; we have nothing further to present.

Representative HOLIFIELD. This will conclude the March hearings. Our present plan is to resume on April 5, after we have had the intervening time to study the hearings and receive the reports that have been promised.

Thank you, gentlemen.

(The following letter was submitted by AEC:)

ATOMIC ENERGY COMMISSION,
Washington, D.C., April 4, 1960.

HON. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: The Atomic Energy Commission and the Atomic Energy of Canada, Ltd., have, as you know, been cooperating for the past 2½ years in a program for the development of heavy water moderated power reactors. The Joint Committee was notified of the scope of this cooperative program in a letter of January 8, 1959. Additional details of the United States-Canadian program were furnished in two letters to Mr. Ramey, dated January 5 and 6, 1960.

As a result of recent discussions between AEC and AECI representatives, it has been agreed that it would be mutually desirable to expand the scope of the cooperative program and to formalize the program by means of a memorandum of understanding within the provisions of the United States-Canada Civil Uses Agreement for Cooperation. Under this arrangement the AEC will have access to all information being developed by Canada in its extensive program on heavy water moderated power reactors and the right to make such information available to U.S. industry for normal commercial use. A copy of the memorandum of understanding which the parties would be prepared to enter into if the necessary authorizations are obtained is attached for the information of the Joint Committee.

The cooperative program would consist of exchange of detailed technical information on design, construction, and operation of current and projected heavy water moderated power reactors included in the programs of AEC and AECL together with research and development, and economic information relevant to such reactors. By exchange of letters between AEC and AECL it has been agreed that the exchange of detailed information will include engineering information and detailed plant designs, including drawings, plans, specifications, and all other technical data developed under the cooperative program. The AEC would undertake certain research and development work, in addition to its present research and development program on heavy water moderated power reactors up to a maximum total cost of $5 million. This additional development work would be specifically directed toward assistance in the design, construction, or operation of heavy water reactors to be constructed by Canada and will be undertaken pursuant to the AEC obtaining the required statutory authorization. The Commission has included a request for such authorization in its authorization requests for fiscal year 1961 under section 261(a)2.

The discussions we have had with Canadian representatives also brought out the desirability of making certain minor amendments to our civil uses agreement for cooperation with Canada. Specifically, we are considering amendments to the following articles:

Article I. To extend the term of the agreement. The present agreement expires July 31, 1965.

Article VI. To include lease and/or loan of special nuclear materials and heavy water, in addition to the present language in paragraphs A and C which now provide only for sale to Canada of these materials.

Article IX. To modify the patent language in this article to enable full implementation of the proposed cooperative program.

Pending signature of the memorandum of understanding, we do not intend to give any publicity to it. We will be pleased to further discuss with the Joint Committee at its convenience, our proposed cooperative program with Canada.

Sincerely yours,

JOHN A. MCCONE, *Chairman.*

MEMORANDUM OF UNDERSTANDING REGARDING THE COOPERATIVE PROGRAM BETWEEN THE U.S. ATOMIC ENERGY COMMISSION AND ATOMIC ENERGY OF CANADA, LTD., IN THE DEVELOPMENT OF HEAVY WATER MODERATED POWER REACTORS

1. Considering that Canada and the United States are each pursuing programs for the development of heavy water moderated power reactors, and that in accordance with the agreement for cooperation concerning civil uses of atomic energy between the Government of the United States of America and the Government of Canada signed on June 15, 1955, as amended (the agreement for cooperation), Atomic Energy of Canada, Ltd. (AECL) and the U.S. Atomic Energy Commission (the Commission) have been cooperating with each other in the achievement of the objectives of their respective atomic energy programs; and

2. Considering that under its program, Canada has under construction a prototype 20 MWE power station, incorporating a heavy water moderated reactor (NPD) and a full-scale, 200 MWE power station incorporating a heavy water moderated reactor (CANDU); that a prototype, 40 MWT organic cooled, heavy water moderated power reactor (OCDRE) is planned for construction contingent upon the results and conclusions of the current design and development program, and that a broad research and development program on heavy water reactor technology in support of the above facilities is also under way; and

3. Considering that under its program, the United States has under construction or authorized a heavy water moderated plutonium recycle test reactor; a heavy water components test reactor; the prototype 17 MWE Carolinas-Virginia power station incorporating a heavy water moderated reactor; a broad research and development program in heavy water reactor technology in support of these facilities; and a research and development program on the prototype 50 MWE east central-Florida west coast power station incorporating a heavy water moderated, gas cooled reactor, construction of which will be dependent upon economic promise and other factors; and

4. Considering that these respective programs have now reached the point where the parties can render more effective assistance to one another through more intensive and integrated cooperative efforts, AECL and the Commission hereby agree to this memorandum of understanding (memorandum) which outlines the scope of a cooperative program for the development of heavy water moderated power reactors to be undertaken pursuant to the agreement for cooperation.

COOPERATIVE PROGRAM

5. The cooperative program shall consist of the following:

(*a*) The exchange of detailed information on current and projected heavy water moderated power reactors specified in paragraphs 1 and 2 of annex A, which is incorporated herein by reference, sufficient to enable either party to design, construct, and operate reactors comparable to those specified; together with research and development and economic information relevant to such reactors. The parties will also exchange detailed information, to the extent they may have the right to do so, on additional heavy water power reactors built in their respective countries, during the period covered by this memorandum. It is anticipated that all the information developed under this program will be unclassified. In the event any classified information is developed, its communication will be subject to the agreement for cooperation.

(*b*) The assignment of personnel of the Commission or its contractors to facilities involved in Canada's heavy water power reactor program, and personnel of AECL or its contractors to facilities involved in the United States heavy water power reactor program.

(*c*) The close coordination by the parties of research and development already in progress or authorized so as to be of maximum feasible application to the respective heavy water reactor programs of both parties. Paragraph 3 of annex A of this memorandum identifies the areas of research and development which are of current interest.

(*d*) The undertaking by the Commission of research and development work, in addition to that included in the Commission's regular program, at U.S. expense, up to a maximum total cost of $5 million (United States), specifically directed toward the heavy water moderated reactors to be constructed by Canada. The undertaking of this activity is pursuant to specific statutory authorization in the United States. This work will be undertaken by the Commission after close consultation with AECL. In the event the parties agree that additional work, at a cost in excess of $5 million (United States) is mutually desirable, the Commission may seek authorization therefor, but none of the other activities or undertakings described in this memorandum shall be contingent on undertaking such additional work.

(*e*) The mutual use of research and development facilities and reactor test facilities available to the parties in the United States and Canaada, respectively, consistent with the limits of facilities and personnel conveniently available, on such terms and condiitons as may be agreed. Use of U.S. facilities for work specifically directed toward the heavy water moderated reactors to be constructed by Canada will be at the United States regular charges for such work, whether for the account of the United States under paragraph 5(d) or for Canada.

(*f*) The transfer of materials, including source and special nuclear materials, from one party to the other, on such terms and conditions as may be agreed, and as may be required or mutually desired for the cooperative program, subject to any limitations imposed by the agreement for cooperation. In this respect the parties may agree that the Commission will, subject to appropriate authorization and necessary amendments to the agreement for cooperation sell, sell on a deferred payment basis, lease, or loan for a period expiring not later than 5 years after initial operation of the respective reactor, (*a*) heavy water for the CANDU and OCDRE reactors and associated research and development programs, (*b*) such special nuclear materials as may be required for NPD, CANDU, and OCDRE reactors and associated research and development programs.

6. The information received by ARCL and the Commission under this program may be made available to Canadian and American industry for normal commercial use in all countries, subject to any relevant patent rights.

7. With respect to any invention or discovery made or conceived in the course of, in connection with, or under the programs referred to in annex A and the contracts thereunder, but during the duration of this memorandum—

(*a*) each party shall grant to the other party a royalty-free, nonexclusive, irrevocable license, with the right to grant sublicenses, in and to any such invention, discovery, patent application, or patent in the United States and Canada, and subject to the provisions of subparagraph (*b*) in all other countries, for use in the production or utilization of special nuclear material or atomic energy, and, to the extent owned, an additional royalty-free, nonexclusive, irrevocable license, with the right to grant sublicenses, for all purposes.

(*b*) in recognition of the fact that neither country intends to file patent applications on all cases in all countries, each party shall advise the other party promptly of the first patent application filed on each invention concerned, and shall specify the country or countries in which it intends to file, and the other party shall specify, within 6 months, any additional country or countries in which such party wishes patent applications filed on mutually agreed terms; and thereafter the first-mentioned party shall be relieved of any obligation to grant to the other party patent rights in such invention in countries other than the United States, Canada, and the other countries specified by either party.

(*c*) each party waives any and all claims against the other party for compensation, royalty, or award as respects any such invention or discovery, patent application or patent and releases the other party with respect to any such claims.

8. With respect to any invention or discovery in the field of atomic energy, not within paragraph 7 above, in which the rights are owned at present, or

acquired during the period of this agreement, by either party, or an agency or corporation owned or controlled by either party, in the country of the other party, each party agrees to grant to the other party a nonexclusive, irrevocable, royalty-free license, with the right to grant sublicenses, for use in heavy-water moderated power reactors.

9. In connection with the assignment of personnel of the Commission and its contractors to AECL and its contractors, and with the assignment of personnel of AECL and its contratcors to the Commission and its contractors, the Commission and AECL agree that the following reciprocal disposition shall be made of patent rights in and to inventions of discoveries made or conceived by—

(*a*) Personnel of the Commission or its contractors while assigned to AECL or its contractors:

(i) The Government of Canada shall acquire all rights in Canada, subject to a nonexclusive, irrevocable, and royalty-free license, with the right to great sublicenses, to the Government of the United States, for all purposes;

(ii) The Government of the United States shall acquire all rights in the United States and other countries, subject to a nonexclusive, irrevocable, and royalty-free license, with the right to grant sublicenses, to the Government of Canada, for all purposes.

(*b*) Personnel of AECL or its contractors, while assigned to the Commission or its contractors:

(i) The Government of the United States shall acquire all rights in the United States, subject to a nonexclusive, irrevocable, and royalty-free license, with the right to grant sublicenses, to the Government of Canada, for all purposes;

(ii) The Government of Canada shall acquire all rights in Canada and other countries, subject to a non-exclusive, irrevocable, and royalty-free license, with the right to grant sublicenses, to the Government of the United States, for all purposes.

(*c*) Each party waives any and all claims against the other party for compensation, royalty, or award as respects any such invention or discovery, patent application or patent and releases the other party with respect to any such claim.

10. A Joint Technical Board shall be established to advise AECL and the Commission on the overall progress of the cooperative program and on future requirements to meet the objectives of the cooperative program. It will consist of representatives of AECL and the Commission in equal numbers, except as may be mutually agreed, and will—

(*a*) Meet as required and at least once a year to review the cooperative program activities;

(*b*) Prepare at least an annual report to be submitted to AECL and the Commission summarizing progress made and making recommendations, as appropriate, for future work under the cooperative program.

11. Both AECL and the Commission will, to the best of their ability, make available to their respective members of the Joint Technical Board, information and other assistance as may be required for the discharge of their Board members' duties and obligations.

12. This memorandum shall remain in effect until 5 years after initial operation of Canada's first full-scale heavy-water moderated power reactor, unless extended by mutual agreement; provided, however, that it shall not remain in effect after the termination of the agreement for cooperation.

ANNEX A

1. CANADIAN REACTORS AND NUCLEAR FACILITIES

(*a*) AECL has devoted its efforts for many years in the field of atomic energy to the development of the natural uranium fueled, heavy water moderated type of reactor, and has brought this type of reactor to the point of development where—

(i) A prototype, 20 MWE power station (NPD) incorporating a heavy water cooled and moderated reactor is under construction at Rolphton, Ontario, in accordance with the contract between AECL, the Hydro Electric Power Commission of Ontaria and Canadian General Electric Co., Ltd. Initial criticality is expected in the spring of 1961, and the cost is estimated at $32 million.

(ii) A full-scale, 200 MWE power station (CANDU) of similar type is under construction at Douglas Point, Ontario, in accordance with the contract between AECL and the Hydro Electric Power Commission of Ontario. The criticality date is estimated at mid-1964; the estimated costs for this plant are $60 million for construction, with an additional amount of approximately $20 million for design and development.

(iii) A program of research and development has been undertaken in Canada with respect to a heavy water moderated, organic cooled type of power reactor (OCDRE), a 40 MWT prototype of which is planned to be constructed in Canada during the next few years, contingent upon the results and conclusions of the current design and development program (estimated to be available by late 1960).

(*b*) In previous and current support of these program activities, ARCL has brought to bear facilities and personnel at Chalk River, its nuclear powerplant division in Toronto and various contractor organizations. It is contemplated that the reactor test facilities NRX, NRU, PTR, ZEEP, ZED–II, test loops, and other Canadian facilities, as well as any new facilities and organizations used in the heavy water reactor program, will, as appropriate and available, and under terms and conditions as may be mutually agreed, be utilized in connection with the cooperative program.

(*c*) Canada has decided to open a new center in Manitoba to be known as the Whiteshell Nuclear Research Establishment to handle further expansion of work in the field of nuclear research. It will be operated as a division of ARCL. The first major facility is expected to be an organic cooled, heavy water moderated experimental power reactor. The site has been selected and preliminary site work is in progress. It is planned to have the site opened up and construction of the various laboratory and service facilities started in 1961. The initial facilities planned are those needed for a reactor test establishment with emphasis in the chemical and metallurgical fields. The long range planning for this new establishment envisages a development similar to the Chalk River project.

2. U.S. REACTORS AND NUCLEAR FACILITIES

(*a*) Aside from its heavy water reactor production work at Savannah River, the Commission has undertaken a research and development program in heavy water moderated reactors that currently encompasses—

(i) The heavy water components test reactor (HWCTR), currently under construction at the Commission's Savannah River site. When completed and in operation about spring 1961, at an estimated cost, including development, of $12 million, this facility will be capable of testing, under power reactor conditions, various components and fuel assemblies of heavy water power reactors.

(ii) The Carolina-Virginia 17 MWE power reactor project undertaken as a third round cooperative project in accordance with the contract between the Commission and the Carolina-Virginia Nuclear Power Associates, which terminates 5 years after initial operation of the reactor. This heavy water moderated and cooled prototype reactor, using slightly enriched and natural uranium fuel, is expected to be in operation by July 1962, at a cost, including development, estimated to be $31 million.

(iii) The East Central Nuclear Group—Florida West Coast Nuclear Group cooperative project, undertaken in accordance with the contract between those groups and the Commission, which terminates 5 years after initial operation, for the development and construction, subject to contingencies provided for in the contract, of a heavy water moderated gas cooled 50 MWE power station, at a total cost estimated at $50 million. This prototype reactor will utilize slightly enriched fuel.

(iv) The plutonium recycle test reactor (PRTR) courrently under construction at the Commission's site at Hanford. The estimated cost of construction of this facility is $14 million. Although designed and primarily intended to demonstrate the feasibility of plutonium fuel recycling, this reactor when operating, about fall of 1960, will be capable of prooftesting heavy water power reactor fuel assemblies.

(*b*) The Commission activities related to the PRTR and HWCTR are centered at the Hanford Laboratories and the Savannah River plant. Various facilities, such as component test rigs, test fabrication shops, fuel element examination cells, and test loops as well as the test reactors, as well as any new facilities and organizations used in the heavy water reactor program, will, as appropriate and

available, and under terms and conditions as may be mutually agreed, be utilized in connection with the cooperative program.

3. AREAS OF COOPERATIVE DEVELOPMENT

In addition to the mutual use of reactors and nuclear facilities described in paragraphs 1 and 2 annex A, the cooperative program will include areas of research and development which are of mutual interest to the parties and which should therefore be closely integrated. Examples of such areas are listed hereunder; other areas may be identified as work progresses; in some areas, work related to specific reactors to be constructed by AECL may be undertaken by the Commission, pursuant to appropriate authorizations:

(*a*) Development of economic and reliable natural and enriched uranium fuel elements to include development of improved fabrication techniques, testing, and performance evaluation;

(*b*) Development of practical means for extending the burnup of natural and enriched uranium cores as limited by reactivity considerations;

(*c*) Development of fuel handling devices for loading, unloading, and shuffling of reactor fuel;

(*d*) Development of components and improved fabrication techniques for achieving long-term reliability and leaktight performances, including calandrias, seals, heat exchangers, pumps, piping, and valves;

(*e*) Development of improved vapor collection technques to reduce capital costs for containment and for reduction of heavy water inventory;

(*f*) Development of economic and reliable pressure tubes to include improved fabrication and replacement techniques, and performance testing and analyses;

(*g*) Development of practical techniques for fabrication of zirconium and for joining dissimilar metals such as joining ziracloy pressure tubes to stainless steel piping;

(*h*) Determination of long-term in-pile properties of materials such as zirconium and development of materials with improved properties;

(*i*) Development of theoretical and experimental physics data for natural uranium lattices to include basic lattice measurements and determination of reactivity lifetime;

(*j*) Development of improved instrumentation required for reactor tests and operation to include instruments to monitor fuel assemblies for temperature, flow rates, and rupture.

(A statement for the record submitted by Miss Elizabeth A. Kendall follows:)

WASHINGTON, D.C., *March 14, 1960.*

HON. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Washington, D.C.
(Attention of Mr. Toll.)

MY DEAR SENATOR: I submit the enclosed statement, hoping you will permit it to be entered in the hearings now underway touching upon reactors for the Antarctic.

Sincerely yours,

(Miss) ELIZABETH A. KENDALL.

STATEMENT OF ELIZABETH A. KENDALL, TAXPAYER

Are we planning to set up atomic reactors in the Antarctic where we can claim no land and have no administrative control?

When I first began to wonder if we could plan to have atomic reactors in the Antarctic I asked the office of Dr. Lawrence R. Hafstad of the Atomic Energy Commission if this could be done. There were correspondence and/or discussions in 1949 with Dr. Hafstad and James Pickard and Leonard Reichle and I received in the mail the Hafstad speech of July 22, 1949, in Los Angeles, which of course was a great disappointment to me. Dr. Hafstad said on page 8, "At the present time there are no reactors in existence so designed that the heat produced can be made to serve useful purposes." A few years later the

President was proposing the atomic pool for peaceful purposes and it seemed to me if possible our first attention should be given to Antarctic bases. We did not have any bases, but maybe with reactors we could have some, thought I. I talked a bit with Congressman Sterling Cole about it, and, as he indicated there was no security involved. I later on talked to anyone who would talk with me, but there did not seem to be much interest.

It was a gratifying surprise to see Congressman James Patterson introduce a bill for the purpose in the 85th Congress. Unfortunately this bill died without action. Publicly, recently, Adm. George Dufek and more recently Senator Henry Jackson have favored the idea of reactors for the Antarctic. It will be a fine thing if the Joint Committee on Atomic Energy can fill the need.

However, I believe most of the persons above mentioned when they thought about reactors for the Antarctic had a certain definite picture in mind and I know I did. That thought was that reactors for Antarctica would be in facilities on U.S. land. I cannot speak for the gentlemen, of course, but I know that such proviso was always in my thoughts.

Therefore, I am writing today to ask that any authorization for Antarctic atomic reactors to be paid for by taxpayers bear the provision that such vital and advanced devices be located at bases owned and operated by the United States. This will of course entail a sort of precedent-breaking step on the part of your committee in reciting the conviction that the territories earned by the U.S. taxpayers in the Antarctic must be secured under the flag of the United States prior to authorization for those regions of reactors or other advanced devices.

If this be a precedent-breaking policy statement, then so be it—in the interests of and preservation of the United States.

It is to be hoped that the President will decide to reopen the whole Antarctic issue so that the treaty will not be ratified with the Soviets and 10 others to internationalize the Antarctic and abandon any U.S. administration there. He could plan a complete reexamination of all phases of the question in the light of several international developments and in the light of public opinion in this country.

Thus, your committee's foresight in regard to the placing of reactors would be a precautionary step worthy of careful statesmanship. The placing of reactors in the Antarctic would indeed enhance the United States in international prestige, but not if we simultaneously indicate we are too weak to claim our proper territories in the Antarctic.

(Thereupon, at 12:25 p.m., Friday, March 11, 1960, the committee was recessed subject to the call of the Chair.)

53759—60——16

ACT AUTHORIZING LEGISLATION, FISCAL YEAR 1961

TUESDAY, APRIL 5, 1960

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON LEGISLATION,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10 a.m., in room P–63, the Capitol, Hon. Holifield (chairman of the subcommittee) presiding.

Present: Representatives Holifield, Durham, Price, Aspinall, Van Zandt, Hosmer, Bates, and Westland; Senators Anderson, Hickenlooper, and Dworshak.

Also present: James T. Ramey, executive director; David R. Toll, staff counsel; Edward J. Bauser, technical adviser, and Bernard V. Dvoskin, GAO consultant.

Representative HOLIFIELD. The subcommittee will be in order.

The Subcommittee on Legislation of the Joint Committee on Atomic Energy is meeting this morning to continue hearings on S. 3084 and H.R. 10656, the bills as proposed by AEC to authorize appropriations for the AEC for the fiscal year 1961 program. Today we are scheduled to receive testimony concerning section 109 of the bill, which would authorize $40 million for use in the cooperative power reactor demonstration program. During the remainder of this morning and this afternoon we will discuss in further detail the AEC's 10-year atomic-power program, including matters of organization and administration.

Tomorrow morning the subcommittee will discuss the reports and design studies on the nuclear tanker, and on reactors for remote military installations. Wednesday afternoon and Thursday morning we will consider the Stanford accelerator and other high energy physics projects. Thursday afternoon we hope to discuss the reactors for remote military installations in further detail, including testimony by the Bureau of the Budget as to financing techniques.

Our principal witness this morning is AEC Chairman John A. McCone.

We are glad to have you with us, Mr. McCone.

STATEMENT OF JOHN A. McCONE, CHAIRMAN; ACCOMPANIED BY JOHN FLOBERG, COMMISSIONER; JOHN S. GRAHAM, COMMISSIONER; DR. ROBERT E. WILSON, COMMISSIONER; A. R. LUEDECKE, GENERAL MANAGER; DR. FRANK PITTMAN, DIRECTOR, DIVISION OF REACTOR DEVELOPMENT; DR. U. M. STAEBLER, SENIOR ASSISTANT DIRECTOR, DIVISION OF REACTOR DEVELOPMENT; DR. PAUL W. McDANIEL, ACTING DIRECTOR, DIVISION OF RESEARCH; DON S. BURROWS, CONTROLLER, DIVISION OF FINANCE; FRANCIS J. McCARTHY, ASSISTANT CONTROLLER FOR BUDGETS, DIVISION OF FINANCE, ATOMIC ENERGY COMMISSION

COOPERATIVE POWER REACTOR DEMONSTRATION PROGRAM

Mr. McCone. Thank you very much, Mr. Chairman. We are happy to be here this morning to present further testimony on the Atomic Energy Commission's request for authorization of appropriations for the fiscal year 1961. In the earlier hearings on the bill we presented testimony on all sections of the bill except section 109, which relates to the cooperative power reactor demonstration program. Your schedule for these hearings, as you have stated, Mr. Chairman, calls for discussions of the cooperative power reactor demonstration program, the design studies undertaken by the Commission in accordance with the provisions of the 1960 Authorization Act, and on which reports have been submitted to your committee, and certain aspects of the high energy physics program, including the authorization of an accelerator to be located at Stanford University. I will cover each of these briefly, Mr. Chairman, and then we are prepared to answer your questions. The first item is the "Cooperative program."

POWER REACTOR DEMONSTRATION PROGRAM

The Commission's request for authority, in the amount of $40 million, to enter into new cooperative arrangements for the development of civilian power reactors, is covered in section 109 of our proposed legislation for the fiscal year 1961 and was summarized briefly in our previous testimony.

There are 32 AEC and privately owned reactors of various types now in the Commission's current program for development of civilian power reactors; 11 planned for construction; 13 under construction; and 8 in operation. The current stage of development in the various reactor concepts is such that it would be desirable to have the results of further research and development and of operating experience before taking the next step in construction of several of the types considered promising. The 10-year program provided the possible construction of 14 prototype reactors and experiments during that period, phased to developmental experience. We have determined that it would be desirable to proceed in fiscal year 1961 with construction of the 50 to 100 electrical megawatt organic cooled prototype reactor, and third round proposals invited under the 1960 authorization are to be submitted to the Commission by May 2. While no proposals have yet been received, we have indication of possible utility interest. If no acceptable proposal is received, the Commission would plan to construct this reactor at one of its sites at an estimated cost of

$25 million, assuming that the results of research and development confirm the technical and economic feasibility of the project.

PROBLEMS IN DEVELOPING FUEL ELEMENTS

I would like to say at this point, Mr. Chairman, that in my previous testimony I pointed out to your committee that there were some problems in the development of a proper type of fuel element for the organic cooled reactor. These problems have not been solved but, in the month or 6 weeks since I last testified on this subject, progress has been made which has been encouraging to us. We are very gratified and I am very happy to be able to report to you that some of the problems that were unsolved at that time show there are promising possibilities of solution at this moment.

Representative HOLIFIELD. Does that mean you have made progress in the cladding of the elements?

Mr. MCCONE. Yes. Sintered aluminum SAP type cladding gives promise for improving the economics of the organic moderated reactor. The difficulty is in its fabrication and its welding. Some of those problems have been overcome.

Representative HOSMER. You have not run the full run of tests yet?

Mr. MCCONE. We have not run the full run of tests under conditions of irradiation.

Representative HOLIFIELD. This is a fabrication problem?

Mr. MCCONE. Yes, sir. I wanted to mention that, because in my last testimony I had made quite a point of the fact that these problems were not solved, and if they were not solved satisfactorily, then the economics of this type of reactor would not be as nearly favorable as might otherwise be hoped for.

Mr. RAMEY. Has the Commission received any proposal in the third round on this prototype?

Mr. MCCONE. No. As I have said, Mr. Ramey, we have not received a proposal as yet. We have had some discussions with groups who are actively interested, and we are hopeful of receiving a proposal, although the May 2 date is somewhat removed. I think the companies that are interested have not as yet been able to crystallize their plans and put them in final form.

Should we receive an acceptable industry proposal to construct the organic cooled prototype reactor, the Commission could use the $25 million for construction of some other reactor type should the development program warrant construction during this period. Also, $15 million of the additional authorization would be available for research and development assistance for either unsolicited proposals or third round proposals, whichever may develop.

PROPOSED PLANTS IN CALIFORNIA

I would like, if I could, Mr. Chairman, to report to the committee that the status of the two major plants which I discussed when I last appeared—these were two plants proposed by power interests in California—there has been no concrete development in those negotiations, although there has been nothing that you might construe as discouraging.

With respect to the Pacific Gas & Electric project in northern California, negotiations have proceeded satisfactorily. There seems to be no problem there other than the company reaching the conclusion that this is a proper thing for the company to do. This is a big decision for any corporation. It has to consider its full future power demands and fuel supplies as well as the financing that is involved, because these plants cost a great deal of money. I am quite hopeful, although as I say there has been no decision reached by the executives or the directors of that corporation. However, they report to me that there has been nothing in the negotiations that have caused them discouragement.

Representative HOLIFIELD. Time is moving right along on that. These people have been working on this quite a while now. It would seem that they would be ready to come up with a concrete proposal. It has been some time since they let out their studies to different manufacturers, has it not?

Mr. MCCONE. That is correct, sir. I think it was early this year that they received their proposals from the two principal manufacturers who they were considering, and that was reported to you as Westinghouse on the pressurized water and General Electric on the boiling water.

With respect to the Southern California Edison plant, their negotiations are proceeding favorably. As I reported to this committee by letter, there is a very difficult problem of site selection in southern California. As you and Mr. Hosmer know so well, it has become a very densely populated area. The question of securing a site where there is an adequate amount of cooling water and at the same time one that has a satisfactory exclusion area, and a very careful examination of the inversion problem all are matters which are being most seriously considered by the company, by the designing engineers and by the Advisory Committee on Reactor Safeguards, as well as our own Commission staff.

I don't think this is an insurmountable problem. I merely mention it as a problem unique to this particular project.

Representative HOSMER. These added factors would not be present in connection with a conventional plant, at least in the same degree.

Mr. MCCONE. No.

Representative HOSMER. Therefore, it will probably take a little more study.

Mr. MCCONE. They would not be present in a conventional plant at all.

DESALINIZATION REACTOR

Representative HOLIFIELD. What about the desalinization reactor down in San Diego?

Mr. MCCONE. We had a discussion with the Department of the Interior to see if an alternate location could be selected which would be more satisfactory from the standpoint of public health and safety than the Point Loma site. As you know, the Reactor Safeguards Committee has questioned that site. While we do not share their concern to the degree that they expressed it, nevertheless we feel that if a site somewhat more remote were selected, it might be better. That particular site is not too distant from the population center of San Diego. It is almost adjacent to Cabrillo Park, which is visited

by almost a million people a year. Hence we are discussing with the Department of Interior as to whether one of the alternate sites might not be considered and be equally satisfactory to them.

Representative HOLIFIELD. In the meantime is the research continuing on the reactor type?

Mr. MCCONE. Yes; the research is going on on the reactor type.

Representative HOLIFIELD. Is it going to be in any way substantially different from other small reactors of that type?

Mr. MCCONE. It will be different in its simplicity, both in respect to the design and to the materials that go into it. However, it will not be, in our opinion, materially different in a manner that might be a factor in considering a site location from the standpoint of public health and safety.

Would you agree with that, Dr. Pittman?

Dr. PITTMAN. Yes.

Representative HOLIFIELD. I am very much interested in anything that has to do with the desalinization of salt water, but I have questioned in my own mind whether the utilization of an atomic reactor would add anything to the value of the desalinization process. Certainly if we are going to just make an ordinary reactor without any substantial technical differences, there would be no improvement in the art as far as building a reactor is concerned.

Mr. MCCONE. I think later in the hearing Dr. Pittman could go into the details of the design features of that particular reactor, if you would like, Mr. Chairman.

Representative HOSMER. Aside from those, at the time that the matter originally came up, I understand there were some four sites that had at least the preliminary approval of the AEC; is that correct?

Mr. MCCONE. The selection board was appointed by the Department of Interior. The Atomic Energy Commission had a consultant to the selection board.

Representative HOSMER. One of your own people?

Mr. MCCONE. One of our own people, yes.

Representative HOSMER. Was he aware of all these facts and circumstances that the advisory committee has given consideration to?

Mr. MCCONE. Yes, he was.

Representative HOSMER. I take it, then, his judgment respecting them was at variance with that of the advisory committee?

Mr. MCCONE. Somewhat, yes. He did not weigh the hazards as heavily as the advisory committee does.

Representative HOSMER. Is this matter still open with respect to the San Diego location?

Mr. MCCONE. We have given it consideration. We feel that since there were alternate sites, and there is some question as to whether these hazards are involved, it might be more prudent to consider them rather than the Point Loma site.

Representative HOSMER. The advisory board has not gone into those alternate sites from the same standpoint?

Mr. MCCONE. No, I do not believe so. At least they have not reported to the Commission if they have.

Representative HOLIFIELD. Without regard to this particular problem you have there, because I don't have all the material at my fingertips right now, I think the general principle of having alternate sites is a good one and certainly the careful consideration that is being

given to the site problem is, in my opinion, in order. We have this temperature inversion handicap in southern California and we can't wish it away. It is there. It has caused a lot of trouble by holding down all kinds of noxious industrial fumes and concentrating them below the level of the strata of clouds. I think this has to be looked at very carefully before any decision is made. I hope that there can be a decision made that will be favorable toward building one of these large atomic plants somewhere in that area. As a Californian, I would like to see California participate. It is forward looking in so many ways and I would like to see them participate. But I would not want to see them gamble on something that sober judgment would indicate might be hazardous because of the peculiar temperature inversion we have there.

Mr. McCone. I am sure the Commission feels as you have expressed yourself, Mr. Chairman, as does the Reactor Safeguards Committee. I think you have seen their letter to me on this subject in which they share our concern. I do not feel that this is a problem that cannot be overcome. I think that containment, safe containment is entirely possible, and an acceptable containment can and will be worked out. This seems to be the opinion of the engineers. So I therefore have not reached the conclusion that because of the inversion in southern California it is an area in which we cannot safely place these things. I think we have to be cautious about it.

Representative Holifield. Will you proceed, please?

DESIGN STUDIES

Mr. McCone. Turning to the question of reactor design studies, the 1960 authorization act directed the Commission to perform design and engineering studies on a prototype reactor for nuclear tankers and on reactors for remote military installations. The report on reactors for remote military installations was transmitted to your committee by letter of March 31, 1960, and the report dealing with nuclear propulsion for tankers was transmitted by letter of April 1, 1960. During the course of these hearings, we plan to make a detailed presentation of the findings of these studies.

I would like to say, Mr. Chairman, that these studies have been encouraging to the Commission because they do evidence that the improvements in the technology and the advances that have been made reflect favorably in both of these areas, just as they do in central power.

ADDITIONAL FACILITIES FOR HIGH ENERGY PHYSICS RESEARCH

Turning to the question of high-energy physics, there have been transmitted to the committee certain amendments to the 1961 authorization bill covering additional facilities for high-energy physics research. The largest of these facilities is the linear electron accelerator proposed for construction at Stanford University, for which authorization of $107.2 million is now requested, compared with the earlier cost estimate of $105 million submitted in our request of May 1959. We are also requesting increases in the amounts to be authorized for modifications of the bevatron at Lawrence Radiation Laboratory and of the Princeton-Pennsylvania proton accelerator at Princeton, N.J.

(The amendments referred to appear on p. 310.)

The first two accelerators in the energy range in excess of 1 billion electron volts were the Brookhaven cosmotron and the Berkeley bevatron, started up in 1952 and 1954 respectively. Experimental work with these two accelerators has provided much of the basis of our Nation's preeminence in high-energy physics.

Meanwhile, design principles were being developed for achievement of higher particle energies and greater beam intensities. It became apparent several years ago that additional accelerators were required to carry out all the experiments our scientists could foresee as necessary. Four additional multibillion electron volt accelerators were undertaken by the Commission and are now in various stages of construction. These are the alternating gradient synchrotron at Brookhaven National Laboratory, a 30-Bev. proton accelerator, scheduled for completion in June 1960; the Cambridge 6-Bev. electron accelerator, scheduled for completion in July 1961; the Princeton-Pennsylvania 3-Bev. proton accelerator at Princeton, N.J., scheduled to be completed in July 1961, and the 12.5 Bev. zero gradient synchrotron at Argonne National Laboratory and that is scheduled for completion late in 1962. Each of these machines has unique features for exploring specific areas of research.

In addition, the United States has in operation two smaller machines at the California Institute of Technology and Cornell University capable of accelerating electrons to energies of about 1.5-Bev. and modifications are in progress to increase the rating of the Mark III linear electron accelerator at Stanford University to 1.2-Bev.

The Mark III present accelerator is now of the order of 700 Mev. This machine is to a considerable extent a demonstration of a prototype of the large Standard accelerator which I will deal with in further detail a little later.

HIGH ENERGY PHYSICS INTEREST IN OTHER COUNTRIES

Other countries are also becoming increasingly active in the field of high energy physics. In the U.S.S.R. the 10-billion electron volt (Bev.) proton synchrotron at the Institute for Nuclear Research at Dubna was first operated in 1957. Another major Soviet accelerator is scheduled to be started up in 1960, the 7 Bev. proton synchrotron at Moscow. The Soviet Union has announced a still larger, about 50 Bev. proton, synchroton, and we have been told the site has been selected and some preliminary site preparation undertaken although no construction schedule has been announced. In addition, a recent Pravda news release announced that a 4-Bev. electron linear accelerator at Kharkov was under construction.

We have no confirmation of that latter statement except the Pravda news release.

Two further accelerators are being designed; a 1-Bev. electron synchrotron in Moscow and a 4–6 Bev. electron synchrotron in America.

Representative HOLIFIELD. Let us compare the types and strengths of the accelerators we have in being or we will have in being at the end of 1962 with those that we know they have in being in the Soviet Union. How does our picture show up if we leave out this 50 Bev.?

Mr. MCCONE. If we leave out the 50 Bev., we have larger and more sophisticated machines. First, we will have later this year the 30-Bev. machine at Brookhaven. You are familiar with that machine.

Then we have in operation a 6-Bev. machine at Berkeley, which is an outstanding machine. We will next year bring in the 6-Bev. electron accelerator at Harvard, and the 3-Bev. proton accelerator at Princeton. Then a year later will come the very advanced zero gradient synchrotron at Argonne, which will be 12.5 Bev. We will have a very comprehensive family of machines. I think that the Soviet machines will demonstrate well, and they will do very valuable work. However, I think our machines will be more powerful, and they will have a higher beam intensity, and therefore better prospect of discovering particles.

Representative HOLIFIELD. This 50-Bev. synchrotron of the Soviet Union has not gone according to schedule; has it? Has it not been slowed up for some reason?

Mr. MCCONE. I had the impression, Mr. Chairman, that they slowed this machine up somewhat, although I do not have any specific dates as to their original schedule and their present schedule. I was told when I was over there that they had selected a site in the vicinity of Moscow and some funds had been allocated for site preparation. It is a staggering project. It is going to cost an enormous amount of money. I think that they sought experience with the machines that they had under construction. I don't want to appear to be diminishing their effort nor their skill in this field. We were very impressed with what they were doing, both in the laboratories and the machine itself.

Representative HOLIFIELD. It will take them 4 or 5 years to build that machine?

Mr. MCCONE. I think it will take a full 5 years.

DUBNA BEVATRON

Representative HOLIFIELD. What information do you have on the operation of their Dubna bevatron?

Mr. MCCONE. What is the question?

Representative HOLIFIELD. What information do we have? I have been told informally that they have been having a lot of trouble with it.

Mr. MCCONE. The machine is operating. I have been down and gone all over the machine, and many of our scientists have been there. They have had some difficulty in getting the beam intensity which they first anticipated. This has been a source of considerable trouble to Professor Veksler, who is in charge of it. He has plans to substantially improve it, but whether he will ever be able to bring it up to its hoped for intensity remains to be seen. Perhaps Dr. McDaniel would make a comment.

Dr. MCDANIEL. The injector on the 10-Bev. Russian machine did not produce the expected output of current, and therefore the intensity of the machine itself has been very low. As Mr. McCone pointed out, when Dr. Veksler was over here last winter he had a great many discussions with our people at Berkeley, and I believe he left the country with some ideas as to how he could improve the machine.

25-BEV. SYNCHROTRON NEAR GENEVA

Mr. McCONE. Especially notable, Mr. Chairman, is the recent successful startup in January 1960 of the 25-Bev. synchrotron near Geneva, Switzerland. This machine was built by the European Organization for Nuclear Research, known as CERN, whose membership consists of 12 nations of Western Europe. I think it would be of interest if I would just read to you the names of those nations. They are Belgium, Denmark, France, West Germany, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom, and Yugoslavia. It is quite interesting that Yugoslavia is itself participating in this effort.

In the United Kingdom, a 1-Bev. proton synchrotron first operated in 1953, and a 7.0-Bev. proton synchrotron is under construction near Harwell Atomic Energy Research Establishment and is participated in by several British universities.

I have gone over that machine. Its construction is well advanced, and it is going to be a very, very fine machine.

In France, a 3-Bev. proton synchrotron was placed in operation in 1958, and a 1.0-Bev. electron linear accelerator is nearing completion. In Italy a 1.2-Bev. electron synchrotron was started up in 1959.

Australia and the Netherlands are building proton synchrotrons, and electron synchrotrons are under construction in Germany, Japan, and Sweden.

I just enumerate those, Mr. Chairman, to show that scientists throughout the world are paying a great deal of attention to this field of high energy physics, because it is really the means by which they explore the nature of matter.

LINEAR ELECTRON ACCELERATOR

In 1958 the Commission agreed with Dr. James Killian, then scientific adviser to the President and Chairman of the President's Scientific Advisory Committee, that a complete review of this Nation's program in high energy physics should be undertaken to assess the overall support and priorities of the program. A special panel was appointed to undertake this study consisting of members of the President's Scientific Advisory Committee, and the General Advisory Committee to the Atomic Energy Commission. Dr. Emanuel R. Piore, director of research of the IBM Corp. was chairman of this group. Based on the results of the study and the recommendations of the panel, the President last May recommended the construction of a linear electron accelerator, to be located at Stanford University.

This machine would be of linear design, approximately 2 miles in length, and would be initially built to accelerate electrons to energies in the range of 10 to 20 billion electron volts. The Cambridge electron accelerator, by comparison, will impart energies of about 6 billion electron volts, which is about the maximum attainable in an economical circular machine. Stage I construction is expected to be completed in fiscal year 1966. The design would provide capability for

later conversion, if this were to be considered desirable from a scientific point of view, to achieve particle energies of about 45 billion electron volts. However, the Commission has no plans at the present time for such stage II conversion.

Legislative authorization of the Stanford accelerator was not completed during the last session. During the intervening months the Commission and its staff have conducted comprehensive studies, including visits to the site, dealing with the risk of earthquakes, the technical feasibility of the design, reexamination of cost estimates for construction and operation at both the original and proposed alternative sites, and various details of possible contractual arrangements, including royalties and patents.

Further light was thrown on some of these problems by the report of John A. Blume & Associates, an engineering firm engaged by the Commission in September 1959 to study the proposed project. This study dealt particularly with earthquake risk and general site feasibility, a review and analysis of the cost estimate for design and construction at the initially proposed site, and estimates of earthquake risk and project costs at alternative sites in the vicinity of Stanford University. Copies of the Blume report were provided to your committee on February 27, 1960.

As a result of the Blume study and other investigations made by AEC, we are no longer proposing that the accelerator be constructed in a tunnel. Instead, present plans call for cut and cover construction at the Sand Hill site. This is on the Stanford campus. In the tunnel concept problems of a geological nature were identified which would substantially increase the cost. Use of the cut and cover method of construction enables the project cost to be held down to approximately the original estimate.

Representative HOSMER. May I ask at that point, Mr. McCone, did they look at Moffett Field?

Mr. MCCONE. Yes.

Representative HOSMER. What was the matter with that?

Mr. MCCONE. It was more costly.

Representative HOSMER. It was?

Mr. MCCONE. Yes.

Representative HOSMER. Despite the fact that you get mostly fill there?

Mr. MCCONE. There are construction difficulties there.

Representative HOSMER. Foundation problems?

Mr. MCCONE. Foundation problems and probably other ones. Dr. McDaniel has informed me that the Blume study indicated the earthquake risk in that particular area was more severe.

On the question of electric power, it appears that power from Bureau of Reclamation generating stations will be available prior to completion of the accelerator. The Commission has filed a request for allocation of 50,000 kilowatts for the Stanford project and indicated that the requirement might later increase to 120,000 kilowatts, should stage II be authorized at some future date.

FINANCIAL IMPLICATIONS OF THE LINEAR ELECTRON ACCELERATOR

I particularly wish to direct your committee's attention to the additional financial commitments which are implicit in authorizing appropriations of $107.2 million for construction of this accelerator. During the early part of the 6-year period of design and construction there will be related research and development costs estimated to be about $18 million. This figure was discussed last May when we made our original presentation. Also during this 6-year construction period, there will be a gradual buildup of operating costs associated with the testing of the equipment and preparations for full-scale research, the costs of which, including provision for equipment associated with experiments, will total about $28 million. Therefore, in addition to construction costs of $107 million over a 6-year period, there will be required research and operating costs of about $46 million.

Senator HICKENLOOPER. Is that $46 million total research and operating cost over the 6-year period?

Mr. MCCONE. Yes, that is correct, sir.

Senator HICKENLOOPER. Is that a continuing item? I understand there are operating costs that will go on in the future but I didn't know about this $46 million item.

Mr. MCCONE. The $46 million covers the operating costs and the research and development during the 6-year period of construction.

Senator HICKENLOOPER. Shouldn't that be counted as capital cost?

Mr. MCCONE. No, I don't think so. I think it is rightfully termed an operating cost.

Senator HICKENLOOPER. Will it terminate at the end of the 6-year period, this $46 million cost, or is it continuing? I am trying to define this in my own mind.

Mr. MCCONE. When the full operation of the machine has been achieved, it is expected that the costs of operation of the accelerator and the conduct of research will be in the range of $15 to $20 million annually. In other words, during the period of construction there will be costs which we would class as operating costs and research and development for reasons that I mentioned, which would total over the 6 years $46 million. This would be relatively low in the first year and would build up in later years. Then after the construction is completed, the operation of the machine will cost between $15 and $20 million a year. That will be the amount required to conduct all the experiments and all of the work to be done on the machine plus the normal modifications and additions which seem to arise every year with machines of this type.

Representative HOLIFIELD. I am a little bit confused about the operating costs in that $46 million. The machine won't be finished. How do you have operating costs?

Mr. MCCONE. It arises from the fact that as the machine progresses, you start to build up your operating organization. You bear in mind, sir, that there is a small prototype machine which I mentioned earlier, which will be there. We would gradually assemble an organization and incur expenses necessary to put the machine in proper operation.

Representative HOLIFIELD. There will be probably be some operating costs also in your testing of different components.

Mr. MCCONE. That is correct.

Representative HOLIFIELD. During the period of construction.

Mr. MCCONE. Yes, that is correct.

Representative HOSMER. It costs a lot of money to get the thing in alinement.

Mr. MCCONE. The alinement will be charged to construction. We have gone into that quite carefully, incidentally, and we feel that can be done satisfactorily.

Representative HOSMER. Do you want to discuss now or later if there is any problem regarding priorities regarding the Bureau of Reclamation power among priority customers.

Mr. MCCONE. I would like to discuss that later, if I could.

Senator HICKENLOOPER. I don't like to belabor this point, and I don't care to pursue it any further, particularly. It is a matter of bookkeeping or it may be a matter of which pocket this money comes out of, but I fail to see why the $46 million is not a capital construction cost. It is essentially testing and proving of component parts as you go along, but it is just as essential to do that, I presume, to get a finished and workable machine as it is to get a foundation which one might also term as operating cost under this theory. The only difference I would see that it might make is in the bookkeeping operations, whether certain moneys should be taken out of operating costs or capital investment costs.

Mr. MCCONE. Yes; I think there are two ways to look at costs of that kind, whether it is an accelerator, reactor, or what it is. As you know, our phase I studies of a great many projects are carried on as operating costs. It is only when we get into the actual design of the bricks and mortar that we charge the detailed engineering to the cost of the project.

Senator HICKENLOOPER. It may make no difference, and as I say I don't want to labor the point at all, because undoubtedly the moneys have to be expended.

Mr. MCCONE. My purpose in bringing the point out is that in this area of high energy physics I wanted this committee to know what the whole bill was. As I go on here, you will see that it is quite high.

As a result of these studies and various understandings reached with the proposers and other participants, major problems have been successfully resolved and the Commission is now in a position to urge positive action to authorize and construct this machine.

I would like to say at this point that this machine will be unique in the world. There is no other machine like it, planned or anticipated or thought of. So while I have gone over the work being done in other countries, this will be quite different and separate from any other machine in the world.

OTHER HIGH ENERGY PHYSICS PROJECTS

In addition to the Stanford accelerator project, we are proposing amendments to the draft authorization bill which would increase the amounts to be authorized for two of the high energy physics projects covered in our earlier hearings. The construction additions and modifications proposed are in keeping with the recommendations

of the Piore Panel for maximizing the usefulness of existing accelerators and those already under construction.

The first of these is an amendment to the project for major Bevatron improvements at the Lawrence Radiation Laboratory in Berkeley, project 61–f–6. The projected improvements would be carried out in orderly fashion over a period of years, at an estimated cost of $9,600,000, an increase of $8,500,000 over the original request.

You recall we requested $1,100,000. The improvements will serve the three objectives of increasing the beam intensity, enlarging the associated research facilities to permit simultaneous conduct of multiple experiments, and improving the reliability and flexibility of the Bevatron accelerator. To attain these objectives requires, first of all, construction of additional shielding for which foundations must be provided. Other aspects of the project are provisions for a secondary beam, injector improvements, a modernized control system, and an external beam facility.

The second of these amendments would provide an increase to project 61–f–2—additions to the Princeton-Pennsylvania proton accelerator. Our amendment for this project would provide for additional authorization of $9,470,000, for a total of $10,820,000. The initial portion of this project, to be completed in fiscal year 1962, consists of a new wing for the existing building to provide additional space needed for administration, maintenance, and laboratory purposes, and a new storage building. These facilities were included in our initial authorization request for project 61–f–2, and which we are now amending. The remaining portion of the expanded project is the provision of an external beam room together with supporting facilities. As now constructed, the accelerator can be used only for internal beam experiments. The desirability of providing for an external beam was recognized at inception of the project, and features were incorporated in the design to permit the establishment of external beam facilities. The increased scope of the research to be performed makes necessary additional building space for electronic counting rooms, laboratory, and office use. Operation of the additional equipment requires provision of motor generators, cooling equipment, a water cooling tower, and an addition to the electrical substation. Construction of the entire project would be completed in fiscal year 1963.

AMENDMENT TO ZERO GRADIENT SYNCHROTRON

While we are not suggesting any change to our previously proposed amendment to the zero gradient synchrotron at the Argonne National Laboratory (project 57–d–1) increasing the authorization from $27 million to $42 million, it is apparent now from reports we have from the lab that the detail in support of the amendment should be revised. Based on the most recent information we have received, the $42 million authorization which encompassed two external proton beams and a fully automatic control system for the accelerator is not sufficient to accommodate one of the external beams and the fully automatic control system. Our justifications in support of the project, which have been previously furnished the committee, have been resubmitted to reflect this change.

The situation there is that we have only recently within the last few days received a revised estimate from the Argonne Laboratory that indicated that the original estimated cost of the project outlined to you previously of $42 million will be somewhat higher, on the order of about $4 million. The Commission has not had time to go into this matter exhaustively. We feel that these costs are mounting so high, both from the construction and operating cost of the high energy accelerators, that we are not of a mind to approve a single addition to any one of them until we have made a most exhaustive study of it. For that reason we cannot tell you that we have exhaustively analyzed the laboratory's estimate.

On the other hand, they have presented this information to us, and therefore we must revise our original statement to you.

Representative HOSMER. Does that have to do with the original design, or failures in that to accomplish a purpose, or what is this addition based on?

Mr. MCCONE. It is based on the fact that the machine was originally conceived that experiments would be performed within a circular track. Now, because of developments in the art of running these things, they find that by leading the proton beams off on tangents, they can have a series of areas in which they can conduct experiments.

Representative HOSMER. In other words, this is an added utilization made possible by certain technical discoveries since the original design.

Mr. MCCONE. Yes; technical discoveries and means of utilizing these machines that have really been developed in recent years. I think the committee would be interested to note that when I was down at Dubna, out of Moscow, looking over their machine, I noticed they were building some of these beam areas, and I said to Professor Emelyanov, "What is this? Is this something you did not think of?" He said, "No; this is something that has developed since we built the machine." Then he had some complaint about the cost of it. So they have exactly the same problem we have.

Representative HOLIFIELD. If you have the same experience on the Stanford accelerator, it is going to be pretty bad.

Mr. MCCONE. I think, Mr. Chairman, that we are quite satisfied that this machine as now presented to us is a complete machine.

Representative HOLIFIELD. Let us go to this project 57-d-1, the one we are talking about. We started out with $15 million, didn't we? I am back to the Argonne project now. We started out with an estimate of $15 million. Then in 1958 we increased it to $27 million. Now, you want it increased to $42 million, and you say that your costs are not firm there. This is already in construction, about 17 percent completed.

Mr. MCCONE. That is correct.

Representative HOLIFIELD. Your design work is pretty well done, I guess. You say you have about 60-percent completion on your design work. Do you think we ought to ask for any more authorization at this time when your costs are not firmed up any more than they are?

Mr. MCCONE. I think we ought to ask for $42 million. That is what we are requesting.

Mr. RAMEY. On the Stanford project, is there any estimate of what it will cost to go up to higher intensity in the larger project?

Mr. MCCONE. Yes; there is an estimate, Mr. Ramey. We have not had a chance to examine it carefully. It runs on the order of $45

million. This does not include escalation or contingencies. We cannot comment particularly on that estimate because we just have not gone into it. The Commission has no current plans to increase the energy of the Stanford accelerator above the present plan.

Representative HOSMER. Your power there is a straightforward matter of adding more klystrons?

Mr. MCCONE. Yes.

Representative HOSMER. If there are improvements in them and if they don't burn out as fast as anticipated, there will be more around. It is actually impossible to tell much about it.

Mr. MCCONE. It is really impossible to tell. It would be a substantial amount of money to go to stage II.

Representative HOLIFIELD. We are getting in pretty deep on this Argonne project from the standpoint of cost. It is up to a $42-million estimate from $15 million. Would it be reasonable to expect that $42 million to be increased later on, another $8 million or $10 million?

Mr. MCCONE. I would not think another $8 million or $10 million from any information that we have at hand. If we confine it to one proton beam takeoff, then the $42 million appears to us to be adequate. If we go to more than one, the $42 million will not be adequate.

Representative HOLIFIELD. Is that what is involved in the $4-million estimate? Is that for another takeoff by the Argonne people? I understand that they have kind of a tentative estimate of $4 million more.

Mr. MCCONE. Let us say by confining it to one-beam takeoff, the plant can be built for the $42 million of the current estimate. Is that correct?

Mr. MCDANIEL. If, in addition, you eliminate the fully automatic control device.

Mr. MCCONE. Yes. If the two beam areas are provided and the fully automatic controls are provided, then the cost would be somewhat higher than $42 million.

Representative HOLIFIELD. Would the two-beam takeoff actually double the utilization of the facility?

Mr. MCCONE. This is a matter that we wish to go into in further detail and report to you as to the extent it would improve the utilization of the machine and the importance of it. Because you not only have the capital expenditure, but you have a very substantial increase in operating costs.

Representative HOSMER. You mean you would go into it later this week?

Mr. MCCONE. No, we will not go into this later this week. The $42 million will permit the plant to proceed for a year or so without any problem.

Representative HOLIFIELD. If you look at it in the ordinary sense of an investment where 10 percent additional would double the utilization of the facility it would seem to me you would be justified in coming back for $4 million more. Then we would really be looking at this in terms of increasing it later on from $42 million to $46 million or $47 million.

Mr. MCCONE. In considering this matter, Mr. Chairman, the Commission felt that before they could go any further in this and other projects that we would have to do a considerable amount of independent investigation both as to the desirability and the necessity.

We have not had time to do that. So we are not making that recommendation.

Mr. TOLL. Mr. McCone, as I understand this statement, under the present scope of this authorization the Commission would not be authorized to put in the second external beam or the fully automatic control room, but would have to come back and request further authorization?

Mr. MCCONE. That is correct.

Representative HOLIFIELD. Could that be added at a later time without any major difficulty?

Mr. MCCONE. That is correct.

Representative HOSMER. You are doing the same thing there as you are with the Princeton job.

Mr. MCCONE. That is right.

IMPORTANCE OF HIGH ENERGY PHYSICS RESEARCH

The Commission desires to emphasize that it considers research in the field of high energy physics to be of the highest importance in the Nation's total endeavor in basic research. The Commission therefore believes that the several accelerator projects discussed today should be authorized in order to provide our scientists with the most effective tools we know how to build. We further believe that when these projects are constructed as proposed as fully developed machines they should be supported with operational funds in order to assure their effective utilization.

The Commission concluded that undertaking the Stanford accelerator is logically the next step in a balanced high energy physics program. We are well aware that the national annual cost level for high energy physics construction and operation will soon reach $150 million per year. We consider this degree of effort to be appropriate.

The Commission is deeply conscious that over the years the actual cost for construction and operation of high energy accelerators has proved to be greater than initially expected. However, after extensive examination, we believe that the current estimates of construction and operating cost for the projects discussed today are reasonably dependable.

Representative HOSMER. The last four paragraphs are exceptionally important, Mr. McCone, and I am very happy to hear you read them.

Mr. MCCONE. We felt that this matter was of such great importance to our scientific progress, and also it is such a costly effort that it should be examined not with respect to what was needed this year, but where we were going in future years. Therefore, we very carefully examined each one of these machines. We reached the decision that they should be built so that they could be considered as complete research machines and then operational funds should be provided which would permit their operation in consonance with what might be considered reasonably full utilization. We felt that this should be done without diminishing the effort in other important fields of science. We did not want to see this program go forward and then either have it frustrated or have other fields of science frustrated because of money problems.

Representative HOLIFIELD. I think this is very important, because in taking on a major project like this, if you do it at the expense of many smaller projects that cover a wider field, in my opinion it would

be something that we would have to look into pretty carefully. If there have been substantial cuts in other areas where research money and facilities are needed just in order to start this very expensive major project, it would have to be looked at pretty carefully.

Mr. McCONE. That is the way we felt, Mr. Chairman. We have reached our conclusion and we carried it to the highest councils of Government before we made this recommendation to you.

Representative HOLIFIELD. For instance, in the field of material research, I wonder if that field is adequately exploited at this time, or if it is being curtailed somewhat for budgetary reasons in order to make way for something like this.

Mr. McCONE. We insisted that this stand on its own.

REDUCTION IN REQUESTS

Representative HOLIFIELD. Here in your backup material, in the research division starting with item 6, inorganic material laboratory, the division asked for $2,500,000. That has been knocked out. In the materials research laboratory, University of Illinois, $5,600,000, that has been knocked out. General plant projects, $5.7 million, and that was reduced to $3.5 million. Chemistry laboratory at BNL, the division asked for $6.4 million and that was knocked out. Then you go right on down the list there, and you have what amounts to a funding request of $62 million, and the Commission and the Bureau of the Budget approved $23 million. So that would mean that you had about a $40 million deduction in a wide field there for some reason.

(The list referred to above follows:)

Comparison of U.S. Atomic Energy Commission Research Division requests with estimates as submitted to the Bureau of the Budget—Plant acquisition and construction

[In millions]

Physical research program	Division request		Submission to Bureau of the Budget		Change	
	Authorization	Funding	Authorized	Funding	Authorized	Funding
1. Princeton-Penn accelerator, Princeton University	$10.8	$10.8	$1.4	$1.4	−$9.4	−$9.4
2. Major bevatron improvements, LRL	11.2	4.2	1.1	1.1	−10.1	−3.1
3. High Energy Physics Research Facility, ANL	6.8	1.6	0	0	−6.8	−1.6
4. Radiation laboratory, Notre Dame University	2.2	2.2	0	0	−2.2	−2.2
5. Elementary particle physics laboratory, University of Chicago	.6	.6	0	0	−.6	−.6
6. Inorganic materials laboratory, LRL	2.5	2.5	0	0	−2.5	−2.5
7. Materials research laboratory, University of Illinois	5.6	5.6	0	0	−5.6	−5.6
8. General plant projects	5.7	5.7	3.5	3.5	−2.2	−2.2
9. Chemistry laboratory, BNL	6.4	6.4	0	0	−6.4	−6.4
10. 4th floor, addition to solid State laboratory, ORNL	.2	.2	0	0	−.2	−.2
11. Equipment decontamination building, ORNL	.4	.4	0	0	−.4	−.4
12. Mechanical shops building, LRL	2.6	2.6	0	0	−2.6	−2.6
13. Applied research building, LRL	3.3	2.4	0	0	−3.3	−2.4
14. Sherwood office building, LASL	.2	.2	0	0	−.2	−.2
Projects unchanged	32.0	17.0	32.0	17.0	0	0
Grand total, physical research	90.5	62.4	38.0	23.0	−52.5	−39.4

Mr. McCone. I realize that there are many projects considered desirable by individual laboratories or regional offices that were not approved at one of several levels of review.

Representative Holifield. These were all recommended by the Research Division.

Mr. McCone. I would point out to you that a great many of them were removed by the senior review committees in the staff or by the Commission itself. I am not cognizant of ones which were removed by the Bureau of the Budget as such, although it is possible that they did question some of them. I could go into each one of those in detail.

The program that we have developed we are very satisfied with. There is an increase in the expenditures for our research effort all along the line. We think that that adequately supports our needs. With your permission I would like to read two final paragraphs and that will conclude my statement.

Representative Holifield. Yes.

Mr. McCone. Turning now to new production reactor at Hanford, studies have recently been completed on the economic attractiveness of converting the new production reactor at Hanford to permit the recovery of electric power. We understand that the committee has scheduled a discussion of these studies in executive session on April 8.

Representative Holifield. We have to set that over to the 11th to accommodate some of the members, Mr. Chairman.

Mr. McCone. Yes. I understand that you wanted that on the 11th.

This concludes my prepared statement, Mr. Chairman, and the Commission, the General Manager and the staff stand ready to answer questions you may have on these items.

Representative Holifield. Thank you, Mr. Chairman. Before we go into items of your testimony, I wonder if we can bring up for the record a few of the developments that may have occurred since our 202 hearings on two or three of the items.

ENRICO FERMI REACTOR

The first one I want to ask you about is the fast breeder reactor developments. The statement submitted at the February 202 hearings on the Enrico Fermi plant by PRDC indicates further increases in research and development costs and increases in construction costs and also reports failures of fuel subassembly in tests, and an estimated delay in startup of 4 to 6 months. Do these developments change the Commission's view on the economic and technical promise of fast reactors and has PRDC developed a good fuel element as yet?

Mr. McCone. Speaking to your subject generally, Mr. Chairman, there has been no change whatsoever in the Commission's view of the feasibility and economic potential of the fast breeder reactor.

With respect to the second part of your question, as to the current status of the fuel element development program, I would like to have Dr. Pittman to speak to that.

Dr. Pittman. Sir, I think that the situation with regard to the Fermi reactor is that they have as you know, run into difficulties with the fuel elements. The primary difficulty is one, as I understand it, of the strength of the fuel which is now being corrected by the use of stainless steel in the reactor to give the added strength.

Representative Holifield. Does that make a double cladding?

Dr. PITTMAN. It does add a double cladding to that.

Representative HOLIFIELD. What was the original material?

Dr. PITTMAN. It was zirconium. It was not strong enough under the conditions. It does mean a redesign. What this obviously means is that it introduces a factor in the Fermi reactor of economics. It does not in any way change our feeling of the potential of the fast reactor system. We have recognized all along that one of the big problems was the development of an adequate fuel element for all of the sodium systems and we still feel the same way as we did before.

Representative HOSMER. Do these developments in sintered aluminum cladding have any bearing here?

Dr. PITTMAN. No, sir. The sintered aluminum cladding will not have any impact, I think, at all on this.

Representative HOLIFIELD. The heat level is too high here?

Dr. PITTMAN. Yes. The sintered aluminum is all right for the heat levels of the organic but not for the sodium.

Representative HOLIFIELD. It will mean a delay in the startup date of 4 or 6 months.

Dr. PITTMAN. Yes. Originally if I recall the date it was September of 1960, and now it is the first quarter of 1961.

Representative HOLIFIELD. The first quarter?

Dr. PITTMAN. Yes, sir. So it will be into 1961.

Representative HOLIFIELD. That is to go critical?

Dr. PITTMAN. Yes, sir.

FLORIDA WEST COAST EAST CENTRAL REACTOR PROJECT

Representative HOLIFIELD. The committee recently received a letter from Mr. Sporn on the Florida West Coast East Central Nuclear Group prototype gas cooled reactor project. He reported the most recent project cost estimates exceed the limits of the obligation of the Florida group under the terms of their contract with AEC. Has the Commission formulated any new plans on this project in the light of these developments, or do you think that Mr. Sporn and his associates will be able to raise the necessary extra funds?

General LUEDECKE. We cannot tell what the attitude of Mr. Sporn and his associates is to be. They have reported fully to the Commission and have recommended that the joint research and development program be pursued for the balance of this year with the hope that further development would solve some of the problems of high cost, although they did not offer us an indication that this could be entirely accomplished, and that the cost could come down to the figures set forth in the contract. We have agreed that we would go forward with the research and development for the balance of this year. At the time of the next report we would have to make a decision as to just what we should do. It would be premature to make a decision at this time.

PRICING OF ENRICHED URANIUM AND D_2O

Representative HOLIFIELD. We have a number of letters and so forth that have come in on the general subject of the cost of enriched uranium, that is, the price of it to the user, and the heavy water pricing policy. What is our latest experience on cost trends in enriched uranium production? Is it going up or down?

Mr. McCONE. Our cost trends on enriched uranium have been favorable. We see no reason in the foreseeable future for increasing our charges for enriched uranium. We are not satisfied that the facts are such that we can at this time suggest reducing the price. But we believe that under any foreseeable circumstance there will be no reason to increase the cost.

The general manager stated, with respect to your question on the Florida project, that the staff has not made its final recommendation on the continuation of the research and development program for the balance of the year, but that seems to be the desire of both the staff and the Commission. It has not been formally acted on, just so the record will be straight.

Representative HOLIFIELD. To go ahead with the project.

Mr. McCONE. To go ahead with the research and development for the balance of the year. As you know, that is a joint undertaking with the contractor.

Representative HOLIFIELD. We continue to get letters from different people on this whole subject of the pricing of heavy water compared with our leasing of uranium. We have a letter directed to the staff from Hood Worthington of the Du Pont Co. I will just quote one paragraph here:

The group that met in Washington on March 23 were agreed that it was hard to justify a use charge for uranium including enriched uranium of 4 percent and at the same time require capital charge of 12.5 percent for the D_2O. In effect one trades the use of heavy water for the use of enriched fuel when one goes from the enriched H_2O system to the natural D_2O. In the 300 electrical megawatt reactor first mentioned in this letter, the use of a 4 percent charge for the heavy water inventory would reduce the figure from 1.1 to 0.3 mills. The resulting decrease in total cost to 8.1 mills would increase the attractiveness of this type of reactor.

(The full text of the letter referred to follows:)

E. I. DU PONT DE NEMOURS & CO., INC.,
EXPLOSIVES DEPARTMENT,
Wilmington, Del., March 29, 1960.

MR. JAMES T. RAMEY,
Executive Director, Joint Committee on Atomic Energy,
The Capitol.

DEAR MR. RAMEY: I had hoped to have a few minutes in the informal meeting held on March 23 on the 10-year reactor program in which I could discuss the heavy water reactor program. As it turned out, this was quite impractical. The points that I wanted to make, however, are important enough in giving perspective on the heavy water reactor program to impel me to write them to you.

Du Pont, Sargent & Lundy, and Nuclear Development Corp. of America have just completed DP-480, "Heavy Water Moderated Power Reactors. A Status Report," for the AEC. Much of what I am writing is contained in that report, with considerable supporting detail. The report concludes that the most promising type of heavy water moderated reactor is still the pressure-tube direct-cycle reactor cooled by boiling D_2O. This is the same type that appeared most promising a year ago. The cost of power from a 300-electrical megawatt plant of this type was estimated by Sargent & Lundy as follows, assuming metal fuel:

	Mills per kilowatt-hour
Plant capital costs at 14 percent	5.0
Heavy water inventory charge at 12.5 percent	1.1
Total fuel cost	1.7
Operation, maintenance, and insurance	1.1
Total	8.9

One may ask why this figure differs from the 12.5 mills per kilowatt-hour quoted on page 80 of the AEC's "Civilian Power Reactor Program, Part I, Summary of Technical and Economic Status as of 1959," TID 8516. The reactors were different (DP–480: boiling, pressure tube, direct cycle. TID 8516: pressurized water, pressure vessel, indirect cycle), and we think that the fuel cycle cost is better represented by 1.7 mills than by the 4.2 mills of TID 8516 if our current program of development is successful. Assumptions of success in some amount of development work are implicit in both the 8.9 and 12.5 mill figures.

The importance of the fuel element development program can hardly be overstated: heavy water reactors are physically large, they must be constructed to minimize the loss of coolant, and the capital charges for the heavy water itself area heavy burden. These matters make the fixed charges almost inevitably higher for a natural uranium-heavy water reactor than for an enriched uranium-light water reactor. The operating and maintenance charges are also higher in a heavy water device because of the necessity for tightness, and the certain loss of some heavy water even with the best of maintenance practice. Fuel cycle costs are the only area in which a compensating saving can be made. We have a reasonable expectation that this can be done.

We should not underestimate the competition from fossil fuels. Typical costs for a 300-electrical megawatt coal-fired plant are:

	Mills per kilowatt-hour
Fixed charges	3.4
Fuel cycle cost	3.3
Operation and maintenance	.4
Total	7.1

It is our understanding that a large powerplant in the Philadelphia area is being planned that will have a total unit cost on this basis of 6.3 mills. Projections into the future made with the expectation that it will be possible to extract chemical values from the coal before burning it lead to figures 1 to 1½ mills lower still.

We have been asked many times why it is that the Canadian atomic power workers come out with figures so much lower than the Americans. This question is treated at some length in DP–480, using a 200-electrical megawatt oxide-fueled boiling D_2O reactor as a basis. (Note that this is not the same basis as that used above.) We have converted our cost estimates to the Canadian basis and find that the most important factor is the annual charge for investment, which is set at 14 and 12.5 percent by the U.S. rules and runs about 8 percent by the Canadian. The effect of this and other less significant factors is illustrated in the following table:

[Mills per kilowatt-hour]

	Estimated costs for a 200 electrical megawatts boiling D_2O plant of U.S. design built and operated in Canada	Estimated costs for the 200 electrical megowatts CANDU
Plant capital cost	2.5	2.6
Heavy water inventory	.7	.5
Fuel cost	1.6	1.1
Operation, maintenance, and supplies	1.0	1.4
Total	5.8	5.6

We consider the difference between these figures to be insignificant.

The group that met in Washington on March 23 were agreed that it was hard to justify a use charge for uranium, including enriched uranium, of 4 percent and at the same time to require a capital charge of 12.5 percent for D_2O. In effect one trades the use of heavy water for the use of enriched fuel when one goes from the enriched-H_2O system to the natural-D_2O. In the 300 eMW reactor first mentioned in this letter the use of a 4-percent charge for the heavy water inventory would reduce the figure from 1.1 to 0.3 mills. The

resulting decrease in total cost to 8.1 mills would increase the attractiveness of this type of reactor.

One last item on costs: in comparison with the expenditures on other kinds of reactors, the dollars spent in this country on heavy water designs are relatively few. The AEC shows in figure 34 of TID 8516 a total of $8.2 million spent on D_2O power reactors in the fiscal years 1950–59 period out of a total of $668 million. Even if one increases the D_2O figure on the basis that this type has profited by the development work and experience acquired in the production reactors and to some extent in the other types of power reactors, there can be little doubt that the technology is far from as well developed as, say, that for pressurized-H_2O types.

Your committee has been much concerned with the question of U.S. prototype construction in the D_2O power reactor program. In your letter of March 7 to General Luedecke you noted that the Commission proposes to engage in full scale cooperation with the Canadians in their prototype D_2O reactor design and construction. You raised the question, however, whether or not sufficient technical experience and know-how will be obtained in this country on this concept without the construction in the United States of a natural uranium, heavy water prototype. I will give you my personal reaction to this question. What I write is in no way to be construed as "what Du Pont says." On the purely technical and economic basis if one is considering new production facilities for an old product (and electric power is an old product in this sense) one will go to a new type of facility only if it implies lower costs, greater safety, or the use of a plentiful raw material instead of one in scarce or dwindling supply. None of these things necessarily constitutes a crisis now in the electric power business. In the absence of a crisis it is reasonable to make sure by extensive research and development that the costs will in fact be reduced, the safety improved, or the new raw material usable. Under these circumstances one does not build a pilot plant or prototype until the R. & D. work predicts a favorable outcome of the project, because one has an alternative in construction of more facilities of the type that is already in use. For the present we still have this alternative in the power field. The situation is even more favorable to progress at low cost to us if cooperation with the Canadians can be truly effective, and if their schedule can be maintained. It may be reasonable to plan on this for the present. I conclude that on a purely technical and economic basis, the United States should pursue its R. & D. program vigorously and do all it can to effectuate cooperation with the Canadians.

The question may not be purely technical and economic, however. It may involve national leadership in the nuclear field, national prestige in general technology, conservation of petroleum resources within our borders, or a desire not to have a large fraction of our powerplants dependent upon the supply of U^{235} for reasons of grand strategy. These are matters of statesmanship with which your committee is quite properly concerned. I feel sure that if a prototype were justified by the administration as a part of national policy, one could be built beginning now. It might, however, prove to be obsolete as a result of near-term technological developments.

Very truly yours,

ATOMIC ENERGY DIVISION,
HOOD WORTHINGTON,
Director, Technical Division.

Representative HOLIFIELD. During last year's authorization hearings you discussed the 4-percent use charge basis for enriched uranium versus selling heavy water, using an annual charge of 12.5 percent in the heavy water investment. Are there any plans at this time by the Commission to cost the heavy water and enriched uranium on the same basis? Do you have any comments on this general subject?

Mr. MCCONE. Yes. This question has been considered from time to time. They are two different materials, as you know. Uranium is a special nuclear material, and by law we must retain possession of it. We are at the present time, and I think for the foreseeable future, the only producer of it. For that reason, and for the rea-

sons of its potential use, that must, under present policy, remain in our possession.

Heavy water is not a special nuclear material nor is it a material that is produced exclusively by the Atomic Energy Commission.

Representative HOLIFIELD. From a practical standpoint you could almost say it is produced exclusively from the standpoint of the quantity produced.

Mr. MCCONE. The quantity we produce is enormous, but it is produced in private facilities both here and abroad. You get into this question. You get into the question of beryllium. Are you going to lease beryllium on a 4-percent basis, or graphite? How far are you going to go with this?

Representative HOLIFIELD. Graphite is privately owned and privately produced. To a certain extent beryllium is, too.

Mr. MCCONE. So is heavy water.

Representative HOLIFIELD. Not in the same relative quantity.

Mr. MCCONE. No, I would say not in the same relative quantity. It is a policy decision.

Representative HOLIFIELD. I am not advocating it at this time. I am just exploring the problem. It is another subsidy, of course. If we grant the use of an inventory of heavy water to a natural uranium reactor project, or a very slightly enriched project, it would be another element of subsidy just like the 4 percent leasing of enriched uranium is at the present time. We justify the one on the basis that it is for research and development purposes. But on the other hand, for a different type of reactor, particularly if it is natural uranium fuel, we are penalizing, we might say, the costs of the reactor. Therefore, the costs of that type of reactor would naturally run higher in that it would not have the element of subsidy in it which your enriched uranium reactor would have. I am thinking now from a consistency standpoint. I am not necessarily advocating that you do this. We have set the precedent during this interim period of research and development of subsidizing all of these reactors that use enriched uranium. Of course, the boys that are thinking of the heavy water side of it put up a pretty good story from a standpoint of comparison and consistency. I am not advocating it, but it does look from the standpoint of consistency that they have the Commission on the horns of a dilemma.

Mr. MCCONE. Yes, we are on the horns of a dilemma inasmuch as we want to encourage development of nuclear power in every way possible. At the same time we want to decrease and finally extinguish all forms of subsidy of it.

Representative HOLIFIELD. That is true.

Mr. MCCONE. To that end when this question comes up, it prompts the question of how long should we continue the policy of leasing the slightly enriched uranium. Wouldn't it be better if this industry is going to stand on its own feet and——

Representative HOLIFIELD. I think this would be the last blow. The industry would die entirely if you took away from them their present subsidized access to the enriched uranium and asked them to make a capital investment on that part. We would not have any problems in the reactor field. I do think, though—I read this letter

pretty carefully and studied it—it is a pretty thoughtful letter. I don't know whether you have a copy of it.

Mr. McCone. It was just handed to me. I have not had a chance to read it.

Representative Holifield. After you have had a chance to read it, maybe we can talk some more on this problem.

Representative Hosmer. Doesn't it rather get back to your special nuclear materials discussion? Without this 12.5 percent charge on the heavy water, you are going to be in the heavy water business forever, and it is not going to get out people who have the capital facilities like the people who wrote this letter from Du Pont, to get in the business, and get you out of it. Isn't that kind of a factor in the back of your mind somewhere?

Mr. McCone. Yes. We would think eventually if heavy water is to be a useful material in nuclear-power reactors, industry should supply that. It should be traded on the market and find its level of cost, and so forth.

Representative Hosmer. Incidentally, didn't you just have a patent cost factor in here somewhere?

Mr. McCone. I don't know exactly what you mean.

Representative Hosmer. Isn't there a patent being settled up with the AEC for a considerable amount of money? Does that go into the 12.5 percent capital or otherwise, or am I wrong?

Mr. McCone. Commissioner Floberg will discuss that.

Mr. Floberg. You are referring to the Spevak litigation, I believe, Mr. Hosmer. That has nothing to do with this point.

Representative Hosmer. It has nothing to do with this?

Mr. Floberg. It has nothing to do with this financing point that has been raised here.

Representative Hosmer. Was it on heavy water?

Mr. Floberg. It is on heavy water. Mr. Spevak was one of the pioneers in the whole heavy water process field. This litigation has been going on ever since I have been on the Commission. I believe it has been concluded now, but I am not positive.

Representative Hosmer. It was concluded in some type of payment arrangement.

Mr. Floberg. No, I don't believe so. Regardless of that, it has nothing to do with this point.

Representative Holifield. According to Mr. Worthington's figures here, it would make a difference of about 0.8 mill.

Mr. McCone. Yes, about 0.8 mill.

Representative Holifield. In the comparison of the economics of an enriched fuel reactor with a heavy water natural uranium reactor or a slightly enriched fuel element of the heavy water moderator, shouldn't that be given consideration? I am thinking now of judging and evaluating the situation.

Mr. McCone. Yes, I would think this is well worth considering. If you will remember when we presented our studies last year to your committee on pressurized and boiling water reactors and organic and heavy water, we set forth in the comparisons the effect of leasing heavy water just for the purpose of putting all of them on a par. I can recall that made a substantial difference with heavy water. A large fraction of a mill.

Representative HOLIFIELD. We have a precedent for waiving this heavy water capital investment, do we not, in the case of the Carolina and the Florida projects? It seems to me we waived that for 5 years.

Dr. PITTMAN. Sir, under the third round those reactors such as the Carolina-Virginia reactor, and the Florida west coast, should they go ahead, there is a waiver of the charge for heavy water for the first 5-year period. This 12½ percent that the Du Pont people speak about is on the assumption that they buy the heavy water at the $28 a pound and have to finance that.

Representative HOLIFIELD. I understand that.

Dr. PITTMAN. We do waive on third round research and development projects.

Representative HOLIFIELD. What they are in effect asking is that they be allowed to lease heavy water just the same as other reactor builders lease enriched uranium.

Dr. PITTMAN. Yes, sir, across the board.

Mr. MCCONE. I would like, Mr. Chairman, to take this letter and give you our comments on it. I assure you again that we are anxious to do all we can to stimulate these things. At the same time we don't like to get any more into the subsidy business than we are. In fact, we would like to move the other way, as rapidly as we can.

Representative HOLIFIELD. I would, too. At the same time we had this little informal session with a group of reactor people, scientists, and they pointed this out to us. Then we received this letter from Mr. Worthington and I studied that carefully. I think you have to look at it from the standpoint of consistency and also from the standpoint that this is a temporary arrangement. I would not want to see the enriched fuel leasing go on forever. We are in an interim period here when we are trying out these different kinds of reactors and trying to reach some answers. That would be my only thought on it. I might be constrained to withdraw my traditional opposition to subsidies if I had a good case! I don't know about my colleagues. I have not discussed this with any of them. They might outvote me about 17 to 1 on this committee. So I am not committing anybody.

USE OF $25 MILLION AUTHORIZATION IF THIRD ROUND PROPOSAL IS RECEIVED

Getting back to your statement, if an acceptable industry proposal to construct the organic cooled prototype reactor under the third round is received, how would the $25 million be used, Mr. Chairman?

Mr. MCCONE. We have not made a definite selection of the most desirable, as I said in my statement. There are two or three that look quite promising. Any one of them would require more work in the way of analysis and perhaps conceptual designing than has been done to date. There are some promising concepts. The necessary work of the conceptual designing and the economic appraisal of them will go forward in any event.

Representative HOLIFIELD. Could some of these funds be transferred from construction funds to research and development assistance, if it was desirable?

General LUEDECKE. We have made provision for $10 million of it.

Representative HOLIFIELD. What would you think of putting a proviso in the bill on this item somewhat along these lines:

Provided, That in the event an acceptable proposal is received from industry to construct the organic cooled prototype reactor under the third round, then the amount of funds available under this section shall be reduced by $25 million.

In other words, this would reduce the amount of the bill by $25 million actually.

Mr. MCCONE. If a proposal is received.

Representative HOLIFIELD. Yes.

Mr. MCCONE. We would prefer to have it so as the developments which we feel confident will take place during the next year, as they do take place, we can take advantage of them. We think to have that authority would stimulate a great deal of activity. That might be very constructive to our program.

Representative HOLIFIELD. If we take the precedents which the committee has pretty well approved, which is having the Commission more or less direct research and development into priority lines rather than to wait for people to come in on a grab-bag basis, and just offer something that they think is good, wouldn't this in effect be a kind of a grab-bag for unsolicited proposals that might not fall in line with the priorities which you have established, at least in your own judgment, as to the types of reactors which should go forward and the steps which should be taken in each individual type.

Mr. MCCONE. I can see your concern, Mr. Chairman. I think we could protect ourselves against that. I really feel that we have our program pretty well crystallized in our mind. In fact, the authorization that was made with the flexibility that is proposed here would not in my mind cause the Commission to be tempted to take an unwise step.

Representative HOLIFIELD. What possibility is there of unsolicited proposals in the next fiscal year?

Mr. MCCONE. We are proposing the authority to support research and development on unsolicited proposals to the extent of $15 million.

Representative HOLIFIELD. Of the $25 million?

Mr. MCCONE. No, this is outside of the $25 million. That is what makes it $40 million. The unsolicited proposals are the two which I mentioned to you. We have had some very tentative expressions from engineering firms of groups that are quite actively interested in other lines of development that look very promising, but are still nebulous and we are therefore not prepared to discuss them.

As I reported previously, the Southern California Edison proposal, if received, would be an unsolicited proposal. It would involve a research and development effort on our part.

Representative HOLIFIELD. But it is a type that has been approved by the Commission.

Mr. MCCONE. Yes.

Representative HOLIFIELD. It is not an exotic type. This is along the line of step-to-step development.

Mr. MCCONE. Yes. This is the next step in the evolution of the pressurized water reactor.

REQUIREMENT OF FUNDS FOR RESEARCH PROJECTS

Representative HOSMER. In your answer to the chairman's question about the proviso you didn't like it. You would like to have that $25 million, as you indicated, for some other types of reactor development. I wonder if there is not a further question of equities between utilizing it for that or putting it on some of these projects that the Research Division had in mind on the sheet that the chairman was talking about. In other words, since you have mentioned that the research program is an expensive one, and over the years it has to be within the national objectives, is there not a logical line of inquiry, and that is whether or not some of these funds on reactor or other type applications should not actually be reallocated into the basic fundamental research study?

Mr. MCCONE. I think it would be a mistake for this committee to suggest quite that kind of flexibility. I think these research projects are extremely important. Each of them carries its own significance. I would prefer to discuss them item by item with the committee. There are lots of things involved in the research projects. In the first place, several of them that you mentioned are on university campuses, and that is a problem we have discussed many times. Furthermore, each one of them involves a continuing support that is a very substantial percentage of the cost of the facility itself. I would much prefer to come before this committee with the research projects and defend them as best I can.

Representative HOSMER. What I had in mind, Mr. McCone, was not the abandoning of coming before this committee, but a more searching scrutiny before you do, not only as to the balance within the research program among the various disciplines, but as to the balance between the total for research and the total for these other activities, of which reactor development is one.

Mr. MCCONE. Of course, this matter is under continuing review and was carefully reviewed all through last fall.

Representative HOSMER. For instance, I would like to think of a balance, let us say, between funds going into research and funds going into this tanker reactor which has been one of my pet hates for a long time.

Representative HOLIFIELD. We are going to get to that next, and you can do a little pet hating on that.

Senator ANDERSON. Why don't we all yield to him when he gets ready to hate.

Representative HOSMER. That is all, Mr. Chairman.

THE NEED FOR A TANKER REACTOR

Representative HOLIFIELD. On page 3, reactor design studies, we come to the tanker problem. The question occurs to all of us, whether that should be the next step in the martime reactor field after the *Savannah*. It brings up the problem of this long-advocated tanker. It also brings up the problem which I understand exists in that there is quite a surplus of tankers under present conditions and whether we want to go into this or not right now.

Mr. McCone. You are talking to somebody who is in the tanker business, so I know a good deal about the tanker surplus. There is quite a surplus.

Senator Anderson. There was a brandnew tanker that had never been moved a single foot—I forget who owned it—it was on the east coast.

Dr. Wilson. That is right.

Senator Anderson. Somebody is here who can confirm these things. There was a brandnew tanker built with very substantial assistance, I believe, from the Government, that has never moved a single foot.

Mr. McCone. At the New York shipyard there is a 35,000-ton tanker completed within the last 2 months which the yard gave the owner a year's free dockage because he had absolutely nothing for it to do. There it sits, a magnificent 35,000-ton tanker.

Representative Holifield. I suppose the Government paid for half of it under the maritime law.

Mr. McCone. No.

Representative Holifield. Is this privately owned?

Mr. McCone. On the ways there is a 45,000-ton tanker which will be completed within a few weeks, and the owner claims he has no employment for it whatsoever. These tankers are American tankers and committed to the American flag because they were built under the so-called trade-in-and-build arrangement. What the owners are finding out is that these very large tankers are not very good for the coastwise trade which is restricted to American-flag ships, and when they run offshore they are in competition with foreign-flag ships and can't meet the competition. These men have a very serious problem. However, laying aside the tanker problem, I do not think that our policy with reference to what we might do in the field of a tanker or any other type of nuclear ship should necessarily be dictated by the temporary depressed circumstances of the shipping market. I think we ought to look at this thing carefully and it is up for discussion, I think, tomorrow, and the potentialities of it studied and see what we should do. There are some very attractive possibilities in a tanker.

On the other hand it is far from competitive at the present time.

Senator Anderson. Mr. Holifield asked what should be the next step in the maritime reactor field. What is the AEC view on further development of this gas-cooled prototype for maritime propulsion? I noted that the Reactor Development Division originally recommended $13 million for it. I see on the sheet that that was eliminated by the Commission itself before it was submitted to the Bureau of the Budget.

Mr. McCone. You have in here a development program that in its basic technology is substantially parallel to work that we are doing in other areas. There was a question in our mind. We could not see why they should go forward with this prototype and demonstrate a technology and its application to a ship propulsion when we were proving out the same technology in other ways.

Senator Anderson. I think the question I had, Mr. Chairman, is that just prior to your becoming Chairman of the Commission, about June 1958, General Dynamics was given a contract for the design of a maritime propulsion unit. This gave them free access to restricted data and classified defense information in our naval and rocket projects. Subsequently, they came to Los Alamos and in-

quired a good deal about the technology that was being developed there, because they had a Government maritime contract. Since then they have had a civilian contract for a central station gas cooled prototype powerplant of 40,000 kilowatts. Was the maritime contract dropped when this $13 million came out of the budget?

Mr. McCone. The $13 million involved the actual proposal to build a prototype reactor; is that correct?

Dr. Pittman. That is right.

Senator Anderson. Dr. Pittman, you have some relationship with GE and Westinghouse and North American in this field; is that right?

STUDIES ON MARITIME REACTORS

Dr. Pittman. The General Electric Co., Westinghouse, and Combustion Engineering made the three studies that we have recently submitted.

Senator Anderson. General Dynamics is not in the picture?

Dr. Pittman. Yes. General Dynamics is carrying out a research and development and design study program for us right now.

Senator Anderson. For what?

Dr. Pittman. For a gas-cooled reactor which can eventually be used, if successful, as a maritime propulsion unit.

Senator Anderson. Then they are doing something for a tanker?

Dr. Pittman. No, sir; it is not for a tanker, necessarily: it is for a propulsion unit. The particular design studies are based on a tanker.

Senator Anderson. That is what I thought.

Dr. Pittman. Yes, sir; but the developmental work is aimed at developing the gas-cooled reactor and the closed-cycle turbine to go with it so it can be used for maritime propulsion. We have about $3 million proposed in the 1961 budget to carry on the developmental program. I think it is very important that we develop the gas-cooled reactor and the closed-cycle turbine to the point where we can make a decision, sir, whether they will in fact accomplish the objectives that we think they might in the maritime field.

Representative Hosmer. You say it is important, but is it urgent?

Dr. Pittman. I think it is urgent that we develop the gas-cooled reactor technology. I think that is urgent.

Representative Hosmer. But not particularly for maritime application.

Dr. Pittman. No, sir. I think it is urgent that we carry out the development of the gas-cooled reactor technology, and this technology should be developed, taking fully into consideration all of the potential uses for gas-cooled reactor systems, whether they be for the central station power or the reactors of the type the Army is interested in building or whether they be for the maritime program.

Representative Hosmer. I know; but this has particular application to a turbine-power takeoff.

Dr. Pittman. No, sir. My statement had particular application to two phases: One to developing the reactor itself so that we can get high-temperature gas efficiently and effectively out of the reactor; secondly, of course, the development of the closed-cycle helium turbine, I think, is important for such things as the maritime propulsion.

Representative HOSMER. Then your statement of importance goes to the reactor and not to the gas turbine.

Dr. PITTMAN. My statement of importance was going primarily to the reactor, sir. My knowledge is more in that field than it is in the turbine field.

Senator ANDERSON. That is high-temperature gas which has more civilian application right now than propulsion in vessels; isn't that right?

Dr. PITTMAN. Certainly, the high-temperature gas-cooled reactor systems do have the application to a civilian central station power program of the type of General Dynamics. The gas-cooled reactor at Oak Ridge is another example. We are developing a gas-cooled reactor system for the small reactors of the Army.

Senator ANDERSON. So what started as research and development for Government maritime reactors with access to classified Rover technology has now changed to private cilivian central station technology. Mr. Chairman, you mentioned that two of these big tankers are tied up or are about to be, and you had some experience in that field. May I just express the hope that in view of some of the things that happened on the *Savannah*—I don't try to analyze whether there were some technical errors made or not, but let me say I think there might have been—I hope when we go on the next round that you will continue to apply your practical knowledge in this field so that the same mistakes will not be made again.

Mr. MCCONE. I hope that the *Savannah* is going to come along very satisfactorily.

Senator ANDERSON. I started to say I hope the *Savannah* finally stumbles into greatness, but it is the wrong process.

Mr. MCCONE. A lot of people are working very hard on it. I was up there a week ago and I am hopeful that things are going to come along very well.

Senator ANDERSON. I am glad to hear you say that because it does represent a very substantial investment in this country, not only in money but in hopes and aspirations.

Mr. MCCONE. And in prestige. What we are insisting upon, incidentally, is a very exhaustive test of all components before that ship goes to sea on a trial run.

Representative HOLIFIELD. We are going into this remote-site problem later on in our schedule, but we were pleased to see that in the study of the Kaiser people that several of these sites look pretty good from an economic standpoint.

Mr. MCCONE. Yes; they do. Some of them look very good from an economic standpoint. We are quite encouraged by it. Some of the studies in the past have given results which have been disappointing to us. But what we have done since the receipt of those reports, both on the tanker and the remote sites, is to review some of the estimates to see just how realistic they are.

Representative HOLIFIELD. The tanker estimate did not show up as economic, did it?

Mr. McCone. If you would eliminate costs that might be attributable to the first of a kind, then it looked considerably better, but still not competitive with a conventional tanker of American flag. For offshore work, of course. It would be far from competitive with the world tanker market.

Representative Hosmer. Are your people going to get into some of these potential routes, which they knew nothing about the last time, in evaluating these economic factors in a tanker?

Mr. McCone. Yes; we have that in the report, Mr. Hosmer, and we will be prepared to discuss that with you.

BALANCE IN BASIC PHYSICAL RESEARCH PROGRAM

Representative Holifield. Getting into the high-energy physics part of your statement on pages 3 and 5, I notice there that you bring the amount up to an eventual cost of $150 million a year in that field. Do you feel that you are balancing your basic physical research well or do you feel that you might be placing too much emphasis on the high-energy research in comparison to the others?

Mr. McCone. The Commission is satisfied that this is a proper emphasis. I should bring to your attention, however, that the General Advisory Committee, which has reviewed this matter from time to time, has repeatedly expressed concern that too great an emphais might be placed on high-energy physics as compared with other essential basic research. The President's Scientific Advisory Committee has endorsed the program as recommended by the Commission.

Representative Holifield. I have a rather involved question here, and if you want to have Dr. McDaniel answer it, it is perfectly all right. The question is, What unique features do each of the following machines have: The Brookhaven cosmotron, the Berkeley bevatron, Brookhaven alternating gradient Bev. proton synchroton, 6-Bev. electron accelerator, Princeton-Penn accelerator, 12.5-Bev. zero gradient synchroton at Argonne? That just about covers those fields there. If you want to hit the top differences between those and then submit a more detailed comparative analysis of those for the record, you may do so. At your pleasure, Mr. Chairman. (See p. 433.)

Mr. McCone. I think that is a very important question.

Representative Holifield. I think it would be good to have it in the record.

Mr. McCone. I think it should be in the record. I understand your committee is going to have some time set aside for a discussion of high-energy physics.

Senator Anderson. Didn't you say that is what you would like to do because I would like to have it come up sometime?

Representative Holifield. It does not have to be today.

INCREASE IN RECURRING RESEARCH COSTS

Senator Anderson. I think this is a field that is growing very rapidly. When you use a figure of $150 million on page 12 for every

year, it is a rather substantial figure. If it is going to be that high, we should know what it was set up originally to cost, why it cost more, and how much more is going to keep piling on as the years go along. I think it would be well, Mr. Chairman, if you would take Berkeley and say initially we thought it might be $2 or $3 million a year, and now it is up maybe to $25 million a year. Why? How far off were these physicists, or was not that it at all? I think the answer is that some new things were added, perhaps. You put on some improvements that were probably worthwhile. But it does seem to me that an item of $150 million annually is a rather substantial amount for high-energy physics.

I would be very happy, Mr. Chairman, if at some later date the Commission could come in and deal with that one figure alone because they jumped from $30 or $40 million a year to $150 million a year, and it is something that we ought to be able to explain to the Congress and the American people.

Mr. McCone. Mr. Chairman, with regard to your question——

Representative Holifield. If I may interrupt you, we have it for Wednesday p.m. and Thursday a.m. At that time if you could be prepared to give us a good statement on that, going into the point that Senator Anderson raised, and also some of the unique features of each and also some of the accomplishments of these very expensive tools and some of the objectives that you have in mind in constructing these more expensive machines.

Mr. McCone. I would hope to do that. I would hope that Dr. Williams can be here, and I think he will be here. Of course, he has devoted his life to this work. He can discuss it from a Commission standpoint, and Dr. McDaniel from a staff standpoint, and I think satisfy you and give you the explanation of these various machines.

With reference to your question, Senator Anderson, there have been substantial increases in cost. Some of them are explainable for the reasons you mentioned and that we have been discussing this morning. As far as operating cost, I find that these very low operating costs that were originally considered were for the mere operation of the machine. The operating costs that we deal with now include both the operation of the machine and all of the costs of the performing of the experiments. Heretofore the cost of the experiments has dealt with other classification of accounts.

Finally, an analysis of this reveals that there is a little something of the problem that Admiral Rickover spoke about the other day, of Pope Pius II and his architect.

Senator Anderson. That is true. I wondered if there was any possibility that in this field of high-energy nuclear physics we might find an area where we could work cooperatively with other countries. Do we have to have exactly the same thing that the British and Russians and everybody else have, and must we pursue them individually to come out with our results when these things supposedly have to do with peacetime applications? There is nothing of a defense nature involved in this, is there?

Mr. McCone. None whatsoever.

Senator Anderson. Therefore, wouldn't it be possible to try to sit down and say let us have an International Geophysical Year approach to some of these high-energy physics problems and not build the same thing the Russians or the British build.

Mr. McCone. There is no reason why that should not be done. I think of all of the fields of research that the Commission is involved in, there is a freer exchange in this area than any other.

INTERNATIONAL COOPERATION IN RESEARCH

Senator Anderson. You and I know better than anybody, Mr. Chairman, that we had a little trouble agreeing on what we ought to do on the question of nuclear bans and tests. There may be arguments in that field, but there is no argument in this field. Perhaps if we agree in this field we might find it easier to agree in some other. I am just expressing the hope that the Commission might suggest some very forward-looking steps to see if an international program could not be worked out. Whatever the cost of an international program would be we would save it in not having to build all these side racetracks to run these things to find out what they can do. I am happy that the Atomic Energy Commission constantly comes up with some figures that tell us what the problem is. This $150 million figure is a recent one, and I think it is a very valuable service to call it to our attention.

Now, having had it called to our attention, if we could find some way of dividing up some of these research projects internationally, it might be very useful to us in the future.

Mr. McCone. Certainly this is a field where that is something that should be exhausted. Of course, a great example is the CERN project, in Switzerland, in which there are 12 countries participating. Just how we could work it out on our existing machines, I do not know. But certainly no new machines would be started by this country or any other country without exhausting the possibility of some kind of mutual undertaking.

Representative Holifield. I am not advancing this idea from the standpoint of arguing the point, because I am hopeful that something can be done that would take these basic discoveries and make them universally known. On the other hand, I am wondering if the load of work that is involved—in each one of these instances, both at Brookhaven and Berkeley, you are improving the machines and making more facilities available—this would indicate to me that there is a very heavy workload in existence or anticipated which would in effect make it necessary to have numbers of these tools. Foreign countries might want to use their own bevatrons for particular experiments. I understand it is quite versatile and it is quite possible that a great many different experiments could be performed on the same machine. Our line of inquiry might be different from that of a foreign country. Then again there is the capacity of the workload. We just need more machines for the workload.

Dr. Wilson. There is also the matter of training new scientists, so it is important to have several different centers. We don't have enough scientists to run all of these machines. We have to train a lot of them. That is one reason for having them at quite a lot of different universities.

Representative Holifield. While there is a certain degree of duplication in some of them, at least, there is a duplication in our school buildings and other facilities that we have. It is necessary to have duplication in order to do the thing you say, to carry the additional

training load and also to carry the load of experiments which are desirable with our scientists.

Representative HOSMER. Perhaps, Mr. Chairman, it might go this way. The world needs more than one 12 Bev. synchrotron, but it might not need more than 30 or it might need some other reasonable figure between that. That is what I think we are striking at.

Representative HOLIFIELD. I notice it is 10 after 12. We will adjourn and come back in session at 2 o'clock in this room, and we will go into the 10-year program this afternoon. If it is all right with the committee, we will carry over the rest of this material that we requested just now on the high energy devices and the Stanford accelerator until the Wednesday afternoon and Thursday morning meeting.

(Thereupon at 12:10 p.m., a recess was taken until 2 p.m., the same day.)

AFTERNOON SESSION

Representative HOLIFIELD. The subcommittee will be in order.

TEN-YEAR PROGRAM

This afternoon we will start on the 10-year atomic power program that the AEC has projected. We would be interested in summarizing the number and types of plants and the cost that will be involved, both annually and over the 10-year period.

STATEMENT OF JOHN A. McCONE, CHAIRMAN, ACCOMPANIED BY JOHN FLOBERG, COMMISSIONER; JOHN S. GRAHAM, COMMISSIONER; DR. ROBERT WILSON, COMMISSIONER; JOHN H. WILLIAMS, COMMISSIONER; A. R. LUEDECKE, GENERAL MANAGER, DR. FRANK PITTMAN, DIRECTOR, DIVISION OF REACTOR DEVELOPMENT; DR. U. M. STAEBLER, SENIOR ASSISTANT DIRECTOR, DIVISION OF REACTOR DEVELOPMENT; DR. PAUL W. McDANIEL, DEPUTY DIRECTOR, DIVISION OF RESEARCH; DON S. BURROWS, CONTROLLER, DIVISION OF FINANCE; AND FRANCIS J. McCARTHY, ASSISTANT CONTROLLER FOR BUDGETS, DIVISION OF FINANCE, ATOMIC ENERGY COMMISSION—Resumed

Mr. FLOBERG. Mr. Holifield, I think Dr. Pittman and the General Manager are both well prepared to give you this part of the presentation. If you would like them to go ahead, they can.

Dr. PITTMAN. Mr. Holifield, there was prepared yesterday or given to you yesterday at your request two charts that I think might be useful. They have the same information that is on the document that we gave to you some time ago with regard to the 10-year program.

On chart 1 what we have tried to do is to compare three separate studies that have been made over the past year or year and a half. This chart shows the comparison of the JCAE staff report that came out in August 1958 with the AEC ad hoc committee report of last year, 1959, and the AEC 10-year program which was presented at the 202 hearings.

(The chart referred to follows:)

Comparison of proposed civilian power programs

	JCAE staff report, August 1958	AEC ad hoc committee report, February 1959	AEC 10-year program, February 1960
Time period for program	5 to 7 years	8 to 10 years	9 years.
Electrical capacity	1,000,000 electric kilowatts.	500,000 electric kilowatts.	875,000 electric kilowatts.
Cost per year	$250 to $275 million	$200 to $225 million	$200 million.

Dr. PITTMAN. The time period, you will note in these three studies, was not the same. Your staff study covered a period of only 5 to 7 years. The ad hoc committee report was an 8- to 10-year program, and the AEC program was from 1961 to 1969. So there are 9 remaining years in the program.

Just to give you an idea of the number of kilowatts involved, the estimate of the Joint Committee staff was that there would be a million electrical kilowatts constructed during the period of 5 to 7 years. The ad hoc committee report last year was for a half-million electrical kilowatts. The program we have presented, if all of the prototype reactors are built, is 875,000 kilowatts.

I would like to point out one thing, sir, and that is in the case of the Joint Committee staff report, there were large reactors actually constructed or assumed to be constructed under that program; whereas, in neither the ad hoc committee report nor in the AEC 10-year program did we make the assumption that during this period there would necessarily be constructed any large reactors.

The 10-year program was the developmental program up through the prototype construction stage. The 875,000 kilowatts for the prototypes only.

We did not assume in this estimate any large-scale reactors. Obviously, during that period there will be large-scale reactors, but we did not know how to estimate how many there would be and therefore we left it out of this particular chart.

Representative HOLIFIELD. Those would be built by outside interests rather than the AEC?

Dr. PITTMAN. Yes. Those would be the privately constructed reactors after the AEC had carried out its three-phase developmental program that would make it possible for the utilities. We gave you a time schedule in these charts, sir, that said when we felt the utility owners might make a decision to construct reactors—large-scale reactors—on an economic basis only.

We did, then, at your request, in this chart give the estimated cost of those large-scale reactors.

Mr. RAMEY. That is on your other chart.

Dr. PITTMAN. That is on this chart. We did not put it on this other one. It shows up on the second chart in just a minute.

Mr. RAMEY. It is possible, if it were considered from a slightly different standpoint, that such reactors could be included in the 10-year program.

Dr. PITTMAN. This is certainly right. I think our problem in trying to include them in charts at this stage is how do you predict how

many water reactors or how many pressurized or how many sodium-cooled would be built after we had reached a point where they could be economic.

We assumed that we will carry it to the point where for each of the concepts the utility could make its decision and we could not include it in here. The cost per year for the programs are given in the last line.

$250 million to $275 million was from the Joint Committee staff report. An estimate of $200 million to $225 million from the ad hoc committee report. Our $200 million estimate is from the 10-year report.

The next chart (chart II) is directly taken from the sheets that we made available to you earlier as to the cost of the 10-year program. In this chart we show the reactor concepts for all of the types of reactors that we now have underway and the last item down there, the new concepts.

(The chart referred to follows:)

Analysis of cost of AEC civilian power program, February 1960, for fiscal years 1961–69

[Cost in millions of dollars]

Reactor concepts	Construction		Research and development [1]	Large-scale plants	
	Size	Cost		Possible date for determination of economical construction	Estimated cost (300 electrical megawatts)
	Electrical megawatts				
Pressurized water	20–30 50–100 100	$70	$135	1962	$65
Boiling water	50–100 20–30	45	50	1963–64	65
Nuclear superheat	100	30	60	1968–69	58
Organic cooled	50–100	30	70	1965–66	60
Sodium cooled (fast)	100	30	140	Late 1960's	70
Sodium cooled (thermal)	100	30	35		
Gas cooled	100	30	105	Early 1970's	65
Heavy water		None	55	Late 1960's	100
Aqueous homogenous	50	20	65		
New concepts (3)	50	80	80		
Subtotal (14)		365	795		483
Nuclear technology program			645		
Total (14)		365	1,440		483
Total research and development and construction.		1,805			483

[1] Excluding costs of preoperating research and development and operating and fuel costs on reactors in program prior to fiscal year 1961.

Dr. PITTMAN. We show the construction, the size of the prototypes. You will notice that in each case these are not the large reactors, but prototype reactors that we feel are necessary to reach economic power for each of these concepts.

Mr. RAMEY. For each concept, could you indicate the number of prototypes?

Dr. PITTMAN. Yes. Pressurized water, there are three. One is a small one. We think this would be a 20- to 30-megawatt small prototype required in the next few years.

Secondly, the possibility of another prototype pressurized water reactor of 50 to 100 electrical megawatts to take full advantage of the

results of operation of the Shippingport and Yankee reactors and the other pressurized water reactors that are now being built.

Finally, the possibility of a 100-megawatt spectral shift reactor. The total cost of those three reactors we estimate for construction to be $70 million. The next line down, the boiling-water reactor, we estimate that in the next few years that as a result of the operations of the plants that are now under construction or that are authorized under our 1960 authorization, there will be need for another prototype to get the most out of the boiling-water system.

In addition, we feel that the boiling-water system should be prototyped in the small size. Therefore, we show a small 20- to 30-megawatt reactor for that size range. The estimated cost of these two prototypes is $45 million.

In this particular chart, and for the first time this year, as you recall, we have separated nuclear superheat from the water system and put it out separately. We feel that as a result of the work on Bonus, Pathfinder, and Borax Five, it is felt that we should build a reasonably large-sized prototype. In this we have gone to a 50- to 100-megawatt plant.

We feel it is necessary because you have to have enough channels in both the boiling and superheat for making the superheated steam.

In the case of the organic cooled, over and above the prototype proposed that we now have out under invitation although we are getting the most out of the organic system, by taking advantage of the operation of the experimental reactors of Piqua and OMRE and the prototype, that we will need an additional prototype reactor in the 50- to 100-megawatt range. This project is estimated at $30 million.

In the sodium-cooled system, we have both fast and thermal reactors. In both cases we feel that there will be necessity in the future to build one additional prototype during this period in order to get the full information that is needed for these two systems. The cost is estimated at $30 million.

In the gas-cooled system, we have one prototype to be built to take advantage of the information that comes out of the Oak Ridge experimental reactor, the General Dynamics Philadelphia Electric reactor, and all the other experimental programs in the gas-cooled system we now have underway. We feel there will be need for a 100-megawatt prototype reactor in this case. This is estimated at $30 million.

HEAVY WATER REACTOR REQUIREMENTS

In the heavy water reactor system, because of our cooperative program with Canada and the fact that they are building the CANDU 200-megawatt reactor, and taking into consideration the program we have underway in this country, we are not predicting the construction of any additional prototypes.

We feel that we will be able to make the determination on the economic feasibility without additional prototypes.

Mr. RAMEY. Could I comment there?

You show a large-scale heavy-water plant in the late 1960's. So you will have quite a gap between the period that the small prototype the Canadians built, or even the CANDU project.

Dr. PITTMAN. CANDU is to come in in 1964–65. This assumes 1 or 2 years of operation to start in 1966–67. That is what we meant by the late 1960's.

Mr. RAMEY. Late 1960's would be 1966?

Dr. PITTMAN. The way I divided this was before 1965 it was early, and after, it was late. It was arbitrary. That is as close as I can come on that. What we expected was that the operation of the prototype plus the 200-megawatt reactor would give you enough information so that this decision could be made in the last 1960's. Maybe I should say mid- to late 1960's.

Mr. RAMEY. I think there is a good deal of opinion that it would be possible in the next 2 or 3 years, if we make any advances in heavy-water technology, to go ahead with a prototype in this country.

Dr. PITTMAN. If this proved to be necessary and the information that would be gained from that would add to the information that is coming from the Canadian system, this certainly could and should be done, sir.

The Canadian program is not the only heavy water work, as you well recognize. We have four projects going on in this country, one of which is the small heavy-water reactor. The other is the Florida job which we mentioned this morning which may or may not be built on the schedule we have been talking about.

The heavy-water component test reactor and the plutonium recycle test reactor, certainly the information from all of these reactors will give us the type of information that we need to know when to build a heavy-water reactor. Heavy water is a water-reactor system and the main problems you deal with because you are handling heavy water is its more expensive losses.

Mr. RAMEY. As I understand it, however, on the natural uranium side, you have to build a natural uranium reactor to ever really find out some of your flux patterns and some of your burnup?

Dr. PITTMAN. This is absolutely right. Both of the Canadian reactors are natural uranium reactors.

Turning now to the aqueous homogeneous system, I think we have discussed this program a few times during the past hearings. The situation with regard to the aqueous homogeneous is that we are still making the assumption in this report that the developmental programs that we have underway and which we are continuing to carry out will lead to the construction of a 50-megawatt reactor which is estimated at $20 milllion.

As far as new concepts are concerned, in addition to the reactor experiments that are not included here, we feel that over the next few years the results of constructing four or five small-scale, one-shot type experiments of the OMRE type will lead to information that will contribute to the construction of new concepts and we have indicated three of these in the 50-megawatt range and with an $80 million price tag for the three reactors.

The total for the whole job, looks to the possibility of building 14-prototype reactors costing on the order of $365 million.

RESEARCH AND DEVELOPMENT

The next column on the chart has to do with the research and development costs and we have broken these costs down in two ways, one with respect to the type of research and development that is carried out on the concepts themselves; and secondly, the bottom line, the nuclear technology program, which is the program that has to do

with across-the-board activity, such as chemical processing, fuel fabrication techniques that are generally applicable, waste disposal, reactor safety, and things of more general nature—such as metallurgy, physics, and chemistry in general.

The situation here is that the total of the R. & D., with the breakdowns shown above, is $795 million for this 9-year period for the concepts themselves, and $645 million for the nuclear technology phase of our program.

The $645 million includes the money that is necessary for the facilities that will be needed to carry out the research and development programs.

So the total of the research and development program is estimated at $1,440 million. Adding that to the $365 million for construction this gives us $1,805 million for the total estimated cost of the program. That is how you get the figure of $200 million for the AEC yearly cost which was shown on the previous chart.

Mr. RAMEY. How does that figure of $200 million in annual cost compare with the cost that you are incurring in your civilian program for the fiscal year 1960 and 1961?

Dr. PITTMAN. Could I ask if somebody would add this up for me, please?

Mr. RAMEY. We have a rough one. It would be just about the same.

Dr. PITTMAN. I have been informed that this is about $25 million a year higher than the proposed fiscal year 1961 estimate.

Mr. RAMEY. When you say it is about $25 million more, does that include construction or is that just your R. & D. and facilities?

Dr. PITTMAN. This is just R. &. D. May I get those figures and put them into the record?

Mr. RAMEY. The reason for asking this question is that we have had comments from various sources that say something to this effect: What the Commission's 10-year program could be considered to be is just a projection of what you are doing now, and at a spending rate no greater than what you are doing now, so it is not an expanding program.

It is possibly a better organized and better thought out program or a better predicted program. Do you want to comment on that?

PROJECTION OF CURRENT PROGRAM

Dr. PITTMAN. Yes; I want to comment, particularly, that the program is nothing but a projection of what we are doing now. I think any time you develop a program your projections for the future must be based on what you are doing or know now.

It is perfectly obvious, and I can only agree, that we are projecting the types of systems, such as water, organic, sodium, and the gas systems, on the basis of what we are now working, will be the systems over the next 10 years that offer the greatest likelihood of meeting the objectives of competitive power.

Therefore, from that standpoint there is no question but what we are doing is projecting a continuation of the type of work that we have been carrying out. I think that this is perfectly reasonable and logical.

The money, the time, and effort that we put into the water system in the past is beginning now to get to the point where it will pay off

and where we can define fairly accurately the number of reactors that we need to get the most out of it.

I think the fact that we are spending, or have had a rather healthy program in the sodium system in the past, and as of now would necessarily lead us to the conclusion that, unless we find something wrong, it is the type of system we would carry out in the future.

Representative HOSMER. I would like to observe that the rate of program has been very carefully worked out on the expenditure level, at least, by this committee and the Commission over the past 2 years, and it may reflect the wisdom of the work we have done so far.

Chairman ANDERSON. I think that is possible. I hope it is.

Dr. PITTMAN. I have a figure here of approximately $175 million as the amount of money that we are spending at this time, exclusive of the construction but including the operation of all of the existing facilities.

Cost incurred for civilian power program, fiscal year 1961

I. Civilian power:	
A. Government program	$97,900,000
B. Power demonstration reactor program assistance	25,400,000
Subtotal, civilian power	123,300,000
II. Nuclear technology	49,500,000
Total	[1] 172,800,000

[1] This excludes $65 million of expenditures in fiscal year 1961 for construction for both the cooperative and Government programs, authorized prior to fiscal year 1961.

The figures shown on chart 2 do not include the operation or the fuel charges of any of the existing reactors, nor the research and development work that goes into the construction of any of the 32 reactors that we now have under construction or planned.

I would like to point out, however, that some of the authorized money for the 32 reactors will be spent in the future. For instance, we are expecting to spend about $7 million on the development of the organic prototype that we now have out on invitation. That is not included in chart 2 costs because that is a part of the program that we have already taken credit for under the 1960 authorization.

It does include the R. & D. money for any of the new prototypes, and cost for the operation of the new prototypes and the base R. & D. program that goes on at Commission and industrial laboratories.

COMMERCIAL-SIZE PLANTS

Mr. RAMEY. On the question of large plants in your right-hand column there, you show what I understand to be the first commercial-size plant that would come in and the cost of it. On the pressurized water and boiling water, the Commission is now considering two plants and has asked for research and development assistance to the amount of $15 million to support commercial-size plants.

It is certainly arguable that the same thing is going to happen with each commercial-size plant on your other concepts—on your superheat, on your organic, on your sodium, and so on.

Dr. PITTMAN. You mean that they will come in earlier than predicted?

Mr. RAMEY. They might come in earlier than predicted with the use of some research and development assistance, or they may not

come in unless they get some research and development assistance from the Government, as in the case of the two that are under consideration now.

Dr. PITTMAN. Could I comment on that from several standpoints, Mr. Ramey?

In the first place, the time schedule that we have shown here is our best estimate on the basis of our present knowledge of what we know and what we can learn in a reasonable time. It is the time schedule when a utility company can make the decision to build a reactor on economics alone and not have to consider that it is gambling on research and development work done after it makes the decision.

The situation with regard to the water reactors that are now under consideration—and I think this has been brought out several times in our testimony—is that these reactors we will expect and the companies expect to be economic over the life of the reactors, but not necessarily at the time that they would first get into operation.

I think this is a little different philosophy. We say that boiling water reactors by 1963 and 1964—the decision could be made on the basis of development programs already having been carried out, that would make them economic in certain high-cost areas.

The same for the pressurized water in 1962. I would be the first to be very, very happy in the event that it turns out that each of these concepts reaches the point of economics sooner than we have predicted here. We have predicted this on the basis of our best judgment today.

This business of predictions is a continuing job. We will undoubtedly have different judgments on the basis of the information that will be available a year from now. If we did not have, then there would be something wrong with our developmental program, and I would feel very bad to come here a year from now—do not hold me to this—and not show you that there has been some change. As you mentioned, some of them are going to be better, I hope, and some of them are certainly liable not to be as good.

Mr. RAMEY. I think if the Commission follows the same pattern as it has on these unsolicited proposals this year, then it would be possible to consider that your large-scale plants are a part of your 10-year program, because the Government is putting research and development money into these plants. It is certainly interested in encouraging the construction of large-scale plants.

In such events, then, you would have a program costing around $2,300 million. You would add the $483 million construction cost, plus some research and development possibly for your well-rounded program of that variety.

Dr. PITTMAN. There are two points to make here. One is that the research and development work that we have estimated necessary to be done is included in the figures that I have given. We have assumed no further research and development work if they do it on that schedule.

If you assume that somebody does it a little earlier and they do some research and development work to fit that particular plant, then you might expect that some of the figures I have shown here would be a little too high.

Secondly, these figures are not Government figures. I do not know how you decide whether the industry is going to build one, two, or

three boiling water or pressurized water reactors or two organic. How do you pick the number?

What we tried to do here then is to show what we felt the AEC program had to be in order to reach these objectives. We have recognized all along that there is a good chance, and we hope an ever-improving chance, that industry will be interested in building these large reactors. To the extent that they do, and to the extent that the program makes sense, we certainly want to be in a position to support them.

To the extent that they do come in, it will certainly add to the overall information of the atomic energy program, but we have not tried to project how many will be built or the fact that it is absolutely necessary that they be built in order to achieve our objectives.

These would be non-Federal dollars that would be added in the event these large reactors were built because we would not be participating in the construction of those reactors.

I think this gives rather quickly all of the information which has already been made available to the committee on these charts, unless there are questions.

Mr. RAMEY. You might show the other chart on comparisons again. You have pointed out the annual level of the AEC program is $200 million. The Joint Committee staff study based on the Edison Institute technical study came out with a figure of $250 million to $275 million. The AEC ad hoc committee report of last January came out with $200 million to $225 million, based on small prototypes.

NOTE.—Pertinent excerpts from JCAE staff study and AEC ad hoc committee report are quoted below:

Joint Committee print, "Proposed Expanded Civilian Nuclear Power Program," August 1958, page 8:

"The scope of the expanded program as envisaged for consideration during the next 5 to 7 years covers a total of 21 reactors of diversified types, including 9 reactors of large size, 4 of intermediate size, 3 of small size, and 5 small reactor experiments, totaling a little over 2 million electrical kilowatts. The type, size, and status of these reactors are given in table I of the appendix. It must be realized that some changes may be required in the types, sizes, and schedules shown in table I. It further is expected only about half of these projects will prove technically and economically desirable for construction.

"ESTIMATED COSTS

"The Joint Committee has made a rough estimate of the costs for these reactor projects. Assuming the capacity of the plants to be constructed at about 1 million electrical kilowatts and the average cost at $500 per kilowatt, the construction effort would amount to about $500 million. The associated design and development cost for this program would total about $375 million of which $250 million would be attributable to plants constructed and $125 million to plants designed but not constructed. The total cost of these projects would therefore amount to $875 million over a 5- to 7-year period. On a 7-year basis, this would average $125 million per year of which a considerable portion would not be borne by the Government. It is expected the base program of general reactor research and development, exclusive of laboratory support facilities, would continue at an average of between $125 million and $150 million per year.

"It should be understood that the expanded program does not include reactors now under construction or already implemented. Nor does it include reactors constructed by private industry not specified in the list of reactor types for the expanded program. Tables I and II of the appendix list, respectively, the new reactor projects contemplated for the expanded program and the reactors already underway or proposed."

Report by Ad Hoc Advisory Committee on Reactor Policies and Programs, U.S. Atomic Energy Commission, January 2, 1959, printed in Joint Committee

hearings on development, growth, and state of the atomic energy industry, 1959, page 534:

"The JCAE program envisaged the construction of approximately a million kilowatts capacity of nuclear power in the next 7 years or so. Our proposed emphasis on prototypes would reduce this to perhaps as low as 500,000 kilowatts. Additional capacity may be financed and built by utilities before the end of that period, thereby increasing the total capacity. Our committee would welcome such construction.

"COST ESTIMATES FOR THE PROGRAM

"The JCAE staff memorandum estimates a total cost, exclusive of laboratory support facilities, for its proposed program of $250 to $275 million a year. About half of this would be for general reactor research and development and the other half for design and construction of specific reactors. These estimates are based on the assumption that a total capacity of about 1 million electrical kilowatts would be built in 7 years. Design costs are included for those reactors actually built and also for those dropped at a late stage on the basis of detailed assessment of cost and value. It must be emphasized that this is total cost, not Government cost.

"If prototypes of average size of 50 electrical megawatts are substituted for the 200 electrical-megawatt plants in the JCAE program, the estimated total cost might be reduced by about $50 million a year and then become $200 to $225 million a year. How much of this would have to be carried by the Federal Government it is impossible to say. Private industry might make a considerable contribution to the costs of construction of prototype plants, but probably most of the design studies for systems not built and most of the research and development would have to be paid for by the Federal Government. Between $150 and $200 million a year is the best guess we can make for the cost to the Federal Government. This does not include the costs of laboratory support facilities or of the Euratom program. Since the corresponding AEC expenditures for the current fiscal year are estimated to be about $190 million, we believe the proposals in the JCAE memorandum and the present report should be called revised programs, not expanded programs, from the national standpoint."

Dr. PITTMAN. Yes; I think I would like to comment on first the differences between the ad hoc committee and the 10-year program report. They were not quite on the same basis. As I said, we have left certain things out of the $200 million that were included in the ad hoc committee $200 million to $225 million estimate.

For instance, the ad hoc committee report was made before we had entered into the program that has the Consumers reactor, the 50-megawatt boiling water reactor, the organic moderated prototype, the small reactor, and the Bonus reactor.

These reactors, at least four, were a part of the ad hoc committee report, and since they have been done I have excluded them.

Mr. RAMEY. This is something that we can check on, but my recollection is that what the ad hoc committee did was to say that the joint committee staff report had large-sized prototypes or commercial-size plants in it and theirs did not and, therefore, they were chopping $50 million off our report. Ours did not include the items you mentioned.

Dr. PITTMAN. I was not trying to argue that point, Mr. Ramey. I was saying when the ad hoc committee made its study they assumed that these other reactors had to be constructed and that the construction or development and construction costs would come out of this $200 million to $225 million.

I have excluded those because they have already been authorized and the program started.

Mr. RAMEY. I do not want to belabor the point, but I think the ad hoc committee took their figures from the staff report.

Dr. PITTMAN. I agree.

Mr. RAMEY. The staff report had the same assumption that you had. That is my recollection.

Dr. PITTMAN. I think your staff report assumed that certain things had to be built that have since gone far enough so that I have not included them in our $200 million estimate. It is not going to be possible for us ever to add up these figures on the debit and credit side exactly.

We have tried to do it for 3 months jointly. Your $250 million to $275 million does include some large reactors which would run up the cost. The size of the program is not too far apart.

STAFFING AND ADMINISTRATION

Mr. RAMEY. We have some other questions now on the staffing and administration of the atomic power program.

Dr. PITTMAN. For this I would like to put some charts on that the committee has not seen because we just finished them late last night. I expect that there have been some changes made on them this morning.

I believe we have supplied to the committee a breakdown of the staffing of the reactor development program in the form of three tables. I would like to discuss our program on the basis of these tables and the charts that I show here.

(The tables referred to above follow:)

TABLE I.—*Total personnel assigned to Reactor Development Division responsibilities*

Period	Total personnel assigned to offices reporting to Reactor Development Division							Personnel directly engaged on reactor development programs at other field offices					Grand total
	Headquarters	IOO	COO	NYOO	LAROO	PNROO	SNROO	ALOO	SAN	HOO	SROO	OROO	
Total June 30, 1959 (actual)	452	389	288	300	91	176	118	18	10	12	4	31	1,889
AEC employees	191	367	288	299	70	92	90	15	10	12	4	30	1,468
Professional	128	133	168	155	10	18	22	12	8	11	3	26	694
Nonprofessional	63	234	120	144	60	74	68	3	2	1	1	4	774
Other Government agency employees	261	22	0	1	21	84	28	3	0	0	0	1	421
Professional	221	15	0	1	21	60	23	3	0	0	0	1	345
Nonprofessional	40	7	0	0	0	24	5	0	0	0	0	0	76
Total Mar. 31, 1960 (actual)	497	413	297	317	104	168	114	20	16	9	13	45	2,013
AEC employees	199	391	297	314	84	93	88	17	16	9	13	44	1,565
Professional	123	146	177	161	14	23	21	11	12	8	9	38	743
Nonprofessional	76	245	120	153	70	70	67	6	4	1	4	6	822
Other Government agency employees	298	22	0	3	20	75	26	3	0	0	0	1	448
Professional	247	15	0	3	20	54	20	3	0	0	0	1	363
Nonprofessional	51	7	0	0	0	21	6	0	0	0	0	0	85
Total June 30, 1960 (estimated)	510	428	318	340	110	169	113	25	18	2	16	50	2,099
AEC employees	210	405	318	337	87	96	90	22	18	2	16	49	1,650
Professional	132	153	195	179	17	28	22	15	15	2	12	43	813
Nonprofessional	78	252	123	158	70	68	68	7	3	0	4	6	837
Other Government agency employees	300	23	0	3	23	73	23	3	0	0	0	1	449
Professional	250	16	0	3	23	53	17	3	0	0	0	1	366
Nonprofessional	50	7	0	0	0	20	6	0	0	0	0	0	83
Total June 30, 1961 (estimated)	517	447	328	346	110	164	113	30	29	7	17	52	2,160

TABLE I.—*Total personnel assigned to Reactor Development Division responsibilities*—Continued

Period	Total personnel assigned to offices reporting to Reactor Development Division							Personnel directly engaged on reactor development programs at other field offices					Grand total
	Headquarters	IOO	COO	NYOO	LAROO	PNROO	SNROO	ALOO	SAN	HOO	SROO	OROO	
AEC employees	217	421	328	343	87	96	90	27	29	7	17	52	1,714
Professional	137	159	203	187	17	28	22	21	21	6	13	45	859
Nonprofessional	80	262	125	156	70	68	68	6	8	1	4	7	855
Other Government agency employees	300	26	0	3	23	68	23	3	0	0	0	0	446
Professional	250	18	0	3	23	52	17	3	0	0	0	0	366
Nonprofessional	50	8	0	0	0	16	6	0	0	0	0	0	80

TABLE II.—*Personnel directly engaged on reactor development programs*

Program period	AEC			Non-AEC			Total		
	Professional	Other	Total	Professional	Other	Total	Professional	Other	Total
JUNE 30, 1959 (ACTUAL)									
Total	388	413	801	345	78	423	733	491	1,224
Civilian	175	127	302	19	5	24	194	132	326
Maritime	20	10	30	20	8	28	40	18	58
Military and space	92	252	344	304	65	369	396	317	713
Engineering and construction	101	24	125	2	0	2	103	24	127
MAR. 31, 1960 (ACTUAL)									
Total	430	444	874	364	86	450	794	530	1,324
Civilian	193	141	334	19	7	26	212	148	360
Maritime	24	14	38	24	9	33	48	23	71
Military and space	102	262	364	318	70	388	420	332	752
Engineering and construction	111	27	138	3	0	3	114	27	141
JUNE 30, 1960 (ESTIMATED)									
Total	489	447	936	365	84	449	854	531	1,385
Civilian	229	145	374	17	7	24	246	152	398
Maritime	25	14	39	24	9	33	49	23	72
Military and space	115	260	375	322	68	390	437	328	765
Engineering and construction	120	28	148	2	0	2	122	28	150
JUNE 30, 1961 (ESTIMATED)									
Total	549	466	1,015	366	81	447	915	547	1,462
Civilian	267	150	417	19	8	27	286	158	444
Maritime	26	14	40	24	9	33	50	23	73
Military and space	131	272	403	322	64	386	453	336	789
Engineering and construction	125	30	155	1	0	1	126	30	156

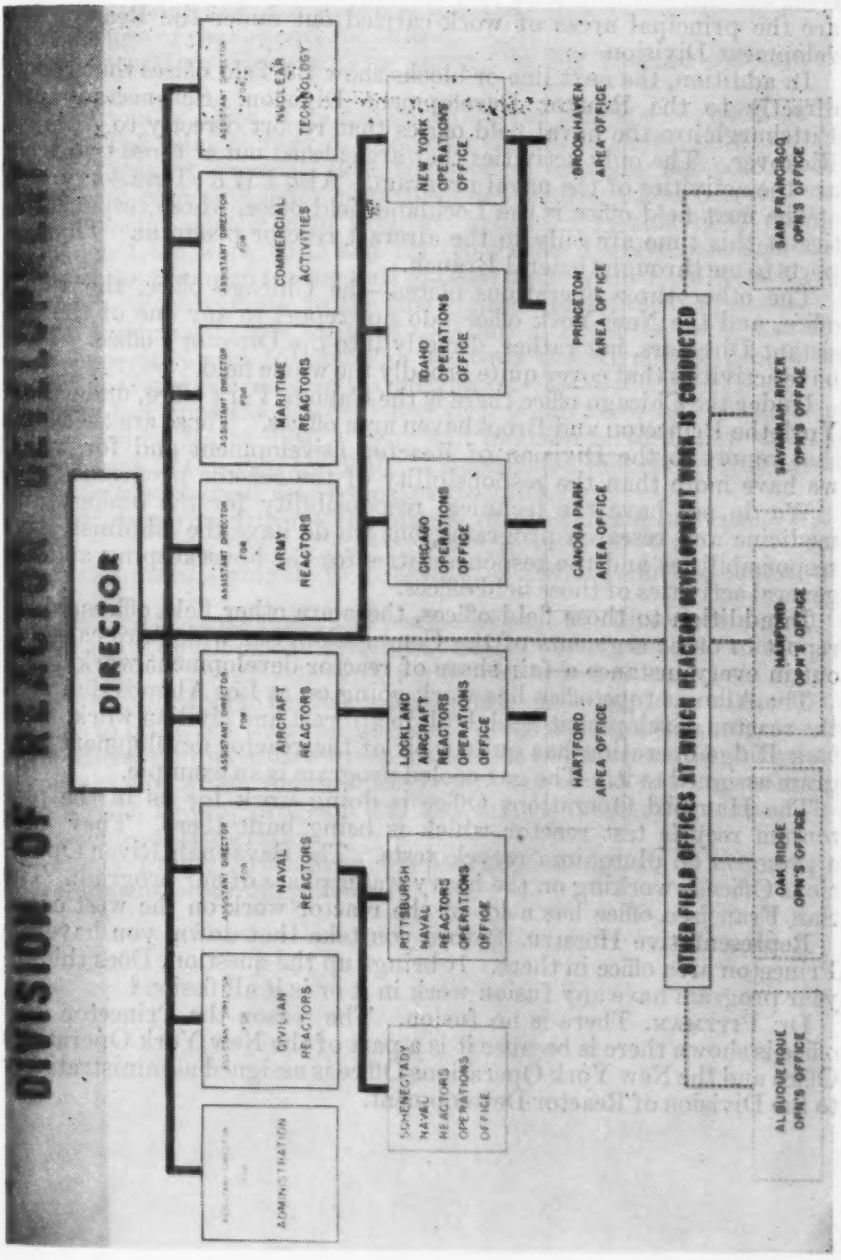
NOTE.—Personnel engaged on general development in nuclear technology are included in the civilian category except where the development work on which they are engaged is of direct application to the maritime or military and space categories.

TABLE III.—*Details of AEC professional (technical and nontechnical) personnel directly engaged in reactor program*

Period	Technical					Nontechnical	Total professional
	Civilian	Maritime	Military and space	Engineering and construction	Total technical		
June 30, 1959 (actual)	129	14	61	76	280	108	388
Headquarters	56	9	13	0	78	50	128
Field	73	5	48	76	202	58	260
Mar. 31, 1960 (actual)	144	15	73	87	319	111	430
Headquarters	50	10	13	0	73	50	123
Field	94	5	60	87	246	61	307
June 30, 1960 (estimated)	174	16	84	97	371	118	489
Headquarters	58	10	14	0	82	50	132
Field	116	6	70	97	289	68	357
June 30, 1961 (estimated)	203	17	96	101	417	132	549
Headquarters	58	10	14	0	82	55	137
Field	145	7	82	101	335	77	412

Dr. PITTMAN. One point that has been evident as we read over the testimony and the discussions that have been held about the staffing of the Reactor Development Division in the past is that in general we take one little segment of the staffing rather than the Division as a whole. So this year I would like to present this very briefly on the basis of what the Division as a whole is doing, and then give you whatever breakdown of the individual activities that you would be interested in having.

(See organizational chart opposite.)


DIVISION OF REACTOR DEVELOPMENT
DIRECTOR
ADMINISTRATION
CIVILIAN REACTORS
ASSISTANT DIRECTOR FOR NAVAL REACTORS
ASSISTANT DIRECTOR FOR AIRCRAFT REACTORS
ASSISTANT DIRECTOR FOR ARMY REACTORS
ASSISTANT DIRECTOR FOR MARITIME REACTORS
ASSISTANT DIRECTOR FOR COMMERCIAL ACTIVITIES
ASSISTANT DIRECTOR FOR NUCLEAR TECHNOLOGY
SCHENECTADY NAVAL REACTORS OPERATIONS OFFICE
PITTSBURGH NAVAL REACTORS OPERATIONS OFFICE
LOCKLAND AIRCRAFT REACTORS OPERATIONS OFFICE
CHICAGO OPERATIONS OFFICE
IDAHO OPERATIONS OFFICE
NEW YORK OPERATIONS OFFICE
HARTFORD AREA OFFICE
CANOGA PARK AREA OFFICE
PRINCETON AREA OFFICE
BROOKHAVEN AREA OFFICE
OTHER FIELD OFFICES AT WHICH REACTOR DEVELOPMENT WORK IS CONDUCTED
ALBUQUERQUE OPN'S OFFICE
OAK RIDGE OPN'S OFFICE
HANFORD OPN'S OFFICE
SAVANNAH RIVER OPN'S OFFICE
SAN FRANCISCO OPN'S OFFICE

I have shown here the organization chart of the Division, going down as far as the Assistant Director level. This gives you the administration, civilian reactors, naval reactors, aircraft, Army, maritime, commercial activities, and nuclear technology branches. These are the principal areas of work carried out under the Reactor Development Division.

In addition, the next line or blocks show the field offices that report directly to the Reactor Development Division. Schenectady and Pittsburgh are the naval field offices that report directly to Admiral Rickover. The only activities that are carried out at those two areas are the activities of the naval program. Also PWR; I am sorry.

The next field office is the Lockland field office, whose responsibilities at this time are only in the aircraft reactor program. That reports to me through General Branch.

The other three operations offices—the Chicago office, the Idaho office, and the New York office—do not report to any one of the Assistant Directors, but rather, directly into the Director's office. They have activities that cover quite broadly the whole field.

Under the Chicago office there is the Canoga Park office, under New York the Princeton and Brookhaven area offices. Those are the offices that report to the Division of Reactor Development and for which we have more than the responsibility of the reactor programs.

We do not have the technical responsibility for the biology and medicine and research programs, but we do have the administrative responsibilities and the responsibilities for the housekeeping and the general activities of those field offices.

In addition to those field offices, there are other field offices which report to other segments of the Commission, but which are carrying out in every instance a fair share of reactor development work.

The Albuquerque office has work going on at Los Alamos that is in the reactor development field, both in aircraft and civilian work. The Oak Ridge operation has quite a bit of the reactor development program assigned to it. The gas-cooled program is an example.

The Hanford Operations Office is doing work for us in the plutonium recycle test reactor which is being built there. They have a program on plutonium recycle tests. The Savannah River Operations Office is working on the heavy water phase of our program. The San Francisco office has a lot of the reactor work on the west coast.

Representative HOSMER. Before you take that down, you have the Princeton area office in there. It brings up the question, Does this 10-year program have any fusion work in it or is it all fission?

Dr. PITTMAN. There is no fusion. The reason the Princeton area office is shown there is because it is a part of the New York Operations Office and the New York Operations Office is assigned administratively to the Division of Reactor Development.

They have programmatic responsibility to other divisions, like biology and medicine and research, but the Operations Office reports to the Division of Reactor Development. We have the housekeeping responsibilities; we have the responsibilities for coordination of the activities; being sure, for instance, that the various program activities have enough of the support facilities.

Representative HOSMER. The answer to my specific question is "No"?

Dr. PITTMAN. Yes. I started out to answer your specific question by "No." The total number of people at the offices shown on the chart (table I) as of June 30, 1959, involved in carrying out reactor development responsibilities, plus those in the other offices carrying out solely reactor development program activities, totaled 1,889 people, of which 1,468 were AEC and 421 from other Government agencies.

I will not try to go through all of these figures, but I will read a few of them. For example, in the line "Other Government agencies," it covers the naval people assigned to Admiral Rickover both here and at Schenectady and Pittsburgh; it covers the Air Force people assigned to General Branch in various places.

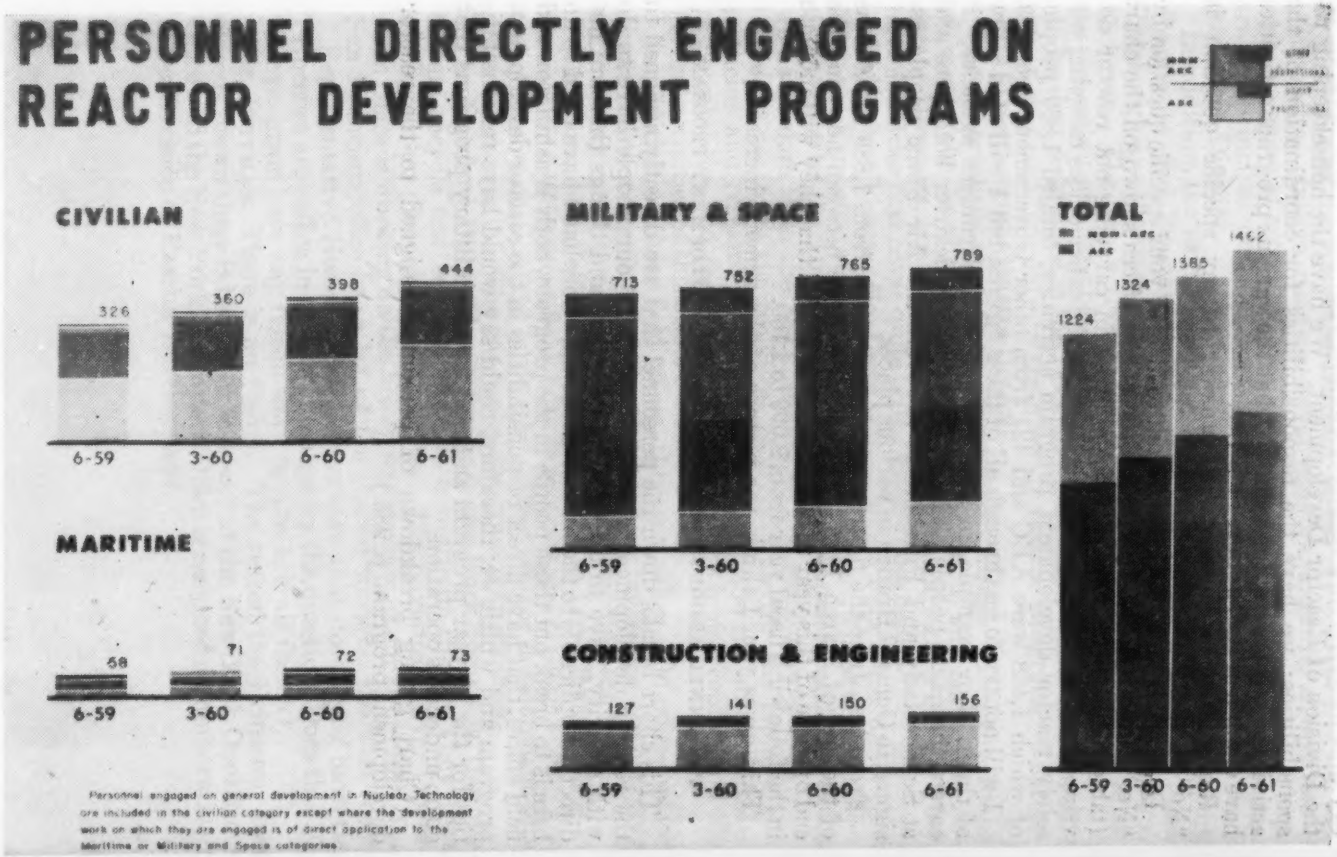
From last June the figures I just read go up from 1,889 to 2,013 as of the end of March 1960. They will increase between now and the end of June of this year to 2,099. It is estimated that they will increase in the following fiscal year from 2,099 to 2,160.

That gives you, I think, the picture of the general increase.

PERSONNEL ASSIGNED TO THE REACTOR DEVELOPMENT PROGRAM

This chart breaks down the personnel that are directly assigned to the reactor development program. A lot of our people have to do with security, have to do with maintenance and things that are not directly applicable to the reactor program. So what I have tried to do here is to break out those people in the program, both Washington and field offices, that have direct responsibilities in the reactor development program and which we, therefore, could say would have responsibilities for the 10-year program and also for the military programs that go on under this operation.

(Chart giving breakdown of personnel assigned to the reactor development program, p. 288.)


PERSONNEL DIRECTLY ENGAGED ON REACTOR DEVELOPMENT PROGRAMS
CIVILIAN
326
360
398
444
6-59
3-60
6-60
6-61
MARITIME
68
71
72
73
6-59
3-60
6-60
6-61
Personnel engaged on general development in Nuclear Technology are included in the civilian category except where the development work on which they are engaged is of direct application to the Maritime or Military and Space categories.
MILITARY & SPACE
713
782
765
789
6-59
3-60
6-60
6-61
CONSTRUCTION & ENGINEERING
127
141
150
156
6-59
3-60
6-60
6-61
TOTAL
1224
1324
1385
1462
6-59
3-60
6-60
6-61

I have broken this down into civilian responsibilities, the military and space programs, and the maritime programs. Then I have added one further breakdown here and that is the construction and engineering group, because the construction and engineering groups are the groups that are responsible in the Commission for seeing that these reactors, whether they be military or civilian or maritime, are properly constructed and the schedules are met and that everything that is done is done to get them built.

Finally the bar on the right is a total bar. This is broken down to show two types of people, those on the payroll that are AEC are in green, and those on the payroll that are non-AEC in yellow. By non-AEC I mean other Government agencies, such as the military or maritime that are assigned to this program.

In case of each of these I have further broken it down to show the professional-technical and nontechnical, as against the clerical and stenographic assistance. You will see that our projections under the civilian program from June 1959 to June 1961 is a steady increase from 326 total at the end of fiscal year 1959 to 444 total at the end of fiscal year 1961, of which the major increase is in the technical people in the AEC program rather than adding much to the nontechnical and nonprofessional.

Mr. RAMEY. Do you have a breakdown on your headquarters professional staff?

Dr. PITTMAN. Yes. I can either break in here or I can give it to you in just a minute on the headquarters staff presentation.

HEADQUARTERS STAFF

Mr. RAMEY. We have a figure here on your professional headquarters staff of 128 as of June 30, 1959, and 123 as of March 31, 1960. For June 30, 132, that is for 1960, and June 30, 1961, 137.

Dr. PITTMAN. Yes. I think you are taking that from table III, isn't that right?

Mr. RAMEY. Table I.

Dr. PITTMAN. Table III gives a detail of the AEC professionals, both technical and nontechnical, assigned directly to the reactor program, broken down in these same categories and distributed between headquarters and field.

For example, taking this, the total technical people directly employed by the AEC on reactor programs—this does not include these other Government agency people—as of June 30, 1959, it was 280. It is 319 as of now, and will go to 371 on June 30, 1960, and 417 by June 30, 1961.

With regard to how these are split between the headquarters and the field, and I think this is the question you were asking, Mr. Ramey, in headquarters there are 78 technical people on the AEC payroll as of June 30, 1959. That figure dropped to 73 people as of March 31, 1960, because during the period we lost 9 people, I believe—I will correct this if I am wrong. We have added some and have 4 more that are just ready to come in but they are not on board as of this moment so that figure would go back up to 82. It will remain at 82 by the end of the next fiscal year.

I would like to comment on this. You will notice within the field organization that the 202 that we had on June 30, 1959, has gone to 246 on March 31, 1960. It is going to 289 by the end of June 1960 and to 335 a year from now.

INCREASED PERSONNEL REQUIREMENTS

The first emphasis that we have had to place on the use of the personnel—increased personnel ceilings that we have gotten and are getting in the next fiscal year—is to build the strength of the field organizations to the point where they, because they are in the field organizations and stay on top of these programs, have the adequate technical strength to do this.

This means I am planning to make it possible for the field organizations to have project engineers assigned right to the place where the reactors are being constructed. Initially they would be construction-type people. Then when it gets into operation, engineers would switch over to the operational-type personnel.

Representative HOSMER. May I ask, then all those people essentially, although technical people, are working on administrative-type duties; is that correct?

Dr. PITTMAN. If your question, sir, is are any of the technical people in the AEC or in the Reactor Development Division working in the laboratory, your assumption is correct. Our people are technical administrators, if that is a way of looking at it. We do all of our laboratory programs and all our work under contract.

Representative HOSMER. Then these people all actually fall into the category of administrative overhead.

Dr. PITTMAN. No, sir; I do not think so. I think this is the group of people, both in Washington and the field, who are responsible for the development of the program, for the administration of the program, and for seeing that the program is properly coordinated.

Representative HOSMER. They are essentially checking on the other guy.

Dr. PITTMAN. If you want to say checking on the other fellow, this is right. But it is checking on the other fellow to the extent of taking the information that he develops and deciding what it is that ought to be done as part of the overall program. We do all our operational work by contract. The contractor people are not included in these figures at all.

Representative HOSMER. I understand that. The direction of my question was whether we were failing to utilize our technical people on technical work. There has been a lot of criticism in industry for having Ph. D.'s in jobs that technicians can handle. I want to inquire whether the AEC is doing the same thing.

Dr. PITTMAN. I think it would be impossible for nontechnical people to evaluate the information, to decide where emphasis ought to be. What makes sense is to consider the work of all of the laboratories and how it fits into the overall program.

You cannot do that with nontechnical people. So the technical people have to be the ones who make these decisions. It cannot be left up to nontechnical people to make them any more than a nonlawyer could make a legal decision.

Representative HOSMER. I may be a little overinfluenced by Parkinson's writings, but that is what I had in mind.

Dr. PITTMAN. I think our problem has been that we have not had the adequate number of people to properly evaluate the work of a good many thousands of people who are doing developmental work.

Representative HOSMER. Dr. Pittman, I realize that must be done. But I think it is a field which has to be carefully policed.

Dr. PITTMAN. It certainly does have to be carefully policed. I think that the problem of policing it is a continual management problem that I certainly feel very strongly about and would hope that we do not build too large an organization which makes an unwidely situation.

Mr. RAMEY. Following along this line, I think testimony has shown that you are increasing your technical people in the field, but you have not been increasing them in the Washington staff.

Dr. PITTMAN. That is right.

Mr. RAMEY. Last year we had a question on the size of your civilian reactors branch as to how many technical people there were, and the number of 37 was mentioned at that time.

Dr. PITTMAN. It seemed to get into the record.

Mr. RAMEY. How does that stack up now?

Dr. PITTMAN. In the civilian reactor group as of June 30, 1959, there were 34 people. The authorized strength of the civilian reactor group is 42 at this time and we are hiring toward that objective.

As I say, we have had some turnover and we have replaced those as rapidly as we could replace them with the proper type of people. It really does not do you any good to bring in people that cannot be useful to you.

In addition to that, I would like again to point out that is not the only group that is working in civilian reactors. The nuclear technology group which has an authorized strength of 29, goes up from an actual 26 as of June 30, 1959, those 29 people are also applying their technical efforts to the development of a civilian reactor program.

There is no question that the work that is being carried out by the military people in the military programs is helpful. The information that is gathered from the operation and activities by the military groups in those programs has an interplay into the civilian program.

The maritime program people, while we have separated organizationally and although not shown under civilian reactors, are doing work on reactors that has a direct application.

The Army people in the small reactor program, those programs have direct application to the civilian activities and vice versa. It is very difficult. You can draw lines on an organizational chart which I did, and you can put numbers to those boxes, but the actual fact is that everybody in this division who is a technical person has a direct impact on everybody else in this division. In spite of the fact that they are in different boxes, the group as a whole is working on all the problems.

Mr. RAMEY. We have gotten a number of comments, however, that the Commission in its Washington staff is technically pretty thin, no matter where they are located, in pushing a large-scale civilian reactor program, particularly in the matter of what you would call program planning and technical direction.

You have to bring in men from the field or from your lab groups to assist you. A part of that is good. On the other hand, we get the impression that your technical people do a good deal of contract review and administration, and perhaps not as much real technical consideration and technical planning and pushing of these things. You are just thin. Not that the people are not of high quality.

Dr. PITTMAN. I cannot argue with you that we are thin because I think it is recognized that we are thin. I think that the situation on how quickly you get fat is how soon you can get the proper type of people in. You do not want to just hire people for the sake of hiring them.

TRAINING PROGRAM

One thing that will be of interest to the committee is that we have just recently started a very active, and I hope successful, training program which we were not in a position to do in any real way before. We are getting the best young people we can get out of the universities to go into a rather extensive training program.

It will last for 18 months, after which time these people will be available as a pool. We have had no pool to draw on to fill the gaps and vacancies that we have when people leave us to go on to other spots in this business. We think that the training program we have underway now will do just that. It has been extremely successful in the military business.

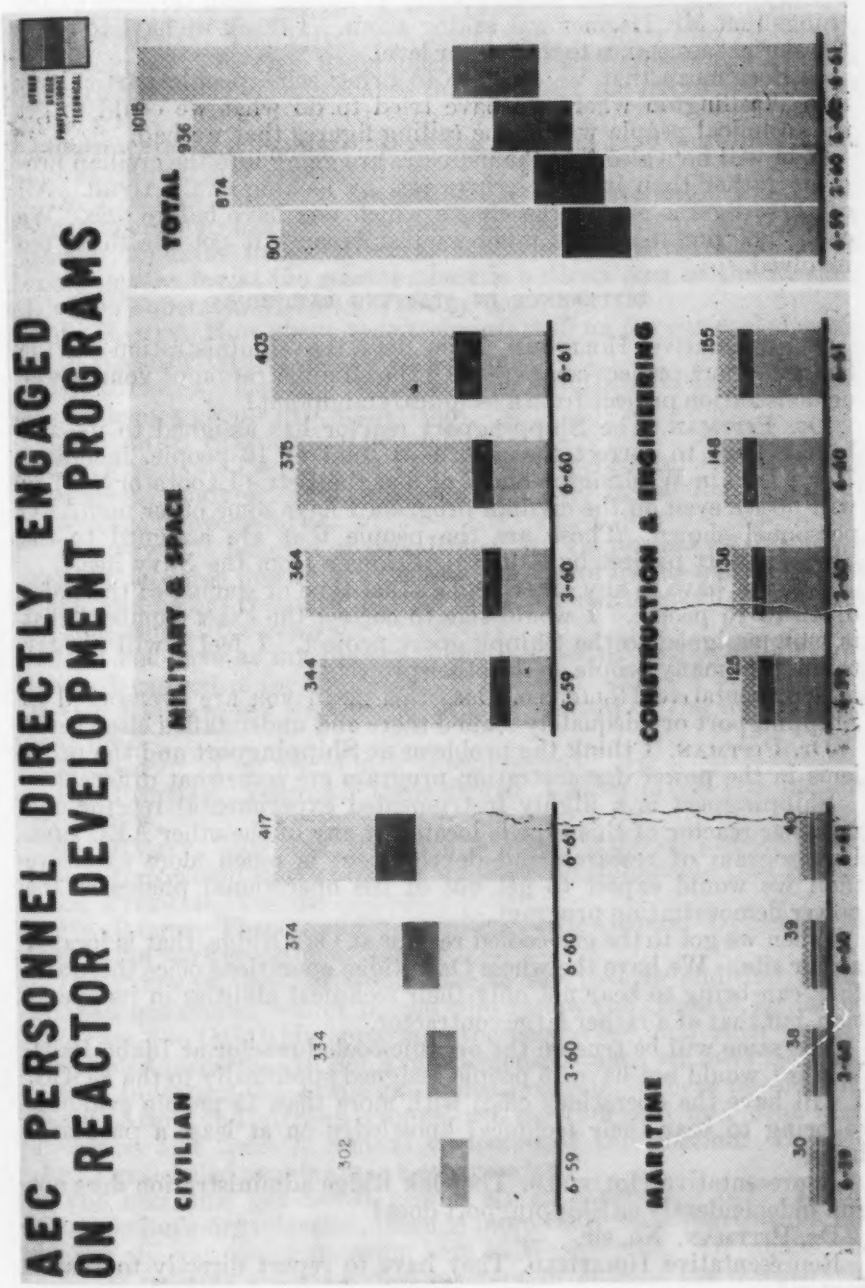
One of the reasons why you see this relatively large number of technical people in the military programs is that they have a trained pool on which they can draw. We think we are now getting into that position, too. Practically all of the people we are bringing into this system, these numbers that I read to you a little earlier, are being assigned into the civilian reactor program because we recognize that is where we are thin, as you put it, Mr. Ramey.

We recognize also that the extent to which contract work is done by the people in Washington should be decreased, and this will be decreased as the field officers build to the point where they can take on technical contract administration.

Our people in Washington can then be responsible for the evaluation and the policy problems that rightly should rest here in the Washington office.

Mr. RAMEY. We notice, however, that your nonprofessional headquarters staff is being increased rather substantially more than your professional staff over this projected period of a year and a half.

Dr. PITTMAN. I would like to show you this chart. The totals show the professionals broken into technical and the other professionals the nontechnical. There is, as you can see, a right sizable increase in the technical people from June 1959 through June 1961. One of the problems we have had is because of the situation under which we have been operating for the past few years. There has been an insufficiency of the clerical help.


AEC PERSONNEL DIRECTLY ENGAGED ON REACTOR DEVELOPMENT PROGRAMS
TOTAL
1015
936
874
901
6-59
3-60
6-61
MILITARY & SPACE
403
375
364
344
CONSTRUCTION & ENGINEERING
155
148
130
125
CIVILIAN
417
374
334
302
MARITIME
40
39
38
30

When I go into an office and find technical people having to do longhand writing because of secretarial shortages, I think this is equally bad utilization of manpower as having them do some of the things that Mr. Hosmer was asking about. I think we have to bring the clerical assistance to the proper level.

It does mean that we do have to bring some people particularly into Washington where we have tried to do what we could to get the technical people within the ceiling figures that we had.

You will note also that the increases are going into the civilian program rather than into the others just by looking at the trend. All of these figures are on the charts which you have before you. We could not put too many numbers just because it got the thing too involved.

DIFFERENCE IN STAFFING PATTERNS

Representative HOLIFIELD. How does the administration of the Shippingport project compare with the administration of your power demonstration project from a technical standpoint?

Dr. PITTMAN. The Shippingport reactor has assigned to it—and I may have to correct the record—a total of 16 people, including 7 or 8 here in Washington and 7 or 8 at the Bettis Laboratory. You will notice even on the civilian program I have some other non-AEC personnel shown. Those are the people that are assigned to the Shippingport project by Admiral Rickover from the Navy itself.

I do not have in any other project that type of staffing of the order of 12 to 15 people. I would like to correct the exact number; that is, now assigned to the Shippingport project. I feel I will not try to put that many people on the other projects.

Representative HOLIFIELD. Does this mean you are overstaffed at Shippingport or adequately staffed there and understaffed elsewhere?

Dr. PITTMAN. I think the problems at Shippingport and the problems in the power demonstration program are somewhat different.

Shippingport is a highly instrumented experimental reactor and no other reactor of this type is located at any of the other AEC sites. Its program of research and development is much more extensive than we would expect to get out of the operational phases of the power demonstration program.

When we got to the gas-cooled reactor at Oak Ridge, that is located at our site. We have the whole Oak Ridge operations office there and they can bring to bear not only their technical abilities in its operation, but that of a rather large contractor.

The same will be true on the organic-cooled reactor at Idaho Falls. While I would not have 15 people assigned specifically to the EOCR, I will have the operations office with more than 15 people available to bring to bear their technical knowledge on at least a part-time basis.

Representative HOLIFIELD. The Oak Ridge administration does not run independently as Shippingport does?

Dr. PITTMAN. No, sir.

Representative HOLIFIELD. They have to report directly to Washington?

Dr. PITTMAN. The Oak Ridge operations office reports to the Reactor Development Division. I am not quite certain what you mean by "independent."

Representative HOLIFIELD. I was thinking of the integration.

Dr. PITTMAN. The Pittsburgh naval reactor office also reports to Washington. The Oak Ridge operations office happens to report to the Production Division because that is where the major part of the work goes.

Representative HOLIFIELD. Does the Director have more independence at Shippingport than he does at Oak Ridge?

Dr. PITTMAN. No, sir. I would say less, if anything. The Pittsburgh operations office is more nearly an integrated part of the naval reactor program under Admiral Rickover while the Oak Ridge operations as far as the reactor phase is a direct part of the Reactor Division's operations here in Washington.

Mr. RAMEY. How about your technical staff on the gas-cooled project in Washington and Oak Ridge?

Dr. PITTMAN. The high temperature reactor branch here in Washington has six people in it at this time.

Mr. RAMEY. Six technical people?

Dr. PITTMAN. Two nuclear engineers, one chemical engineer, one mechanical engineer, and two secretaries. So it has four technical people and two secretaries.

The way it is handled at Oak Ridge, Mr. Sapire has established a Reactor Division down there under a gentleman by the name of Dave Cope, and he has responsibility for all of the reactors and one section is the section on the gas-cooled reactor.

I do not have at my fingertips the number of people assigned to that. I can get it for the record, if you like. A total of 30 people at Oak Ridge in the Reactor Division is planned by the end of fiscal year 1961.

Mr. RAMEY. That would include secretaries?

Dr. PITTMAN. Yes. All these figures I have given you include secretaries.

Mr. RAMEY. This staff you have in Washington on gas-cooled reactors, they would worry about other places in addition to Oak Ridge?

Dr. PITTMAN. Yes, sir.

Mr. RAMEY. They would be working with General Dynamics, as well as the work going on at Idaho?

Dr. PITTMAN. Yes. I would like to say that in addition to the civilian gas-cooled reactor people who follow the General Dynamics program, the Oak Ridge program, the pebble bed, and other civilian gas-cooled projects. In the Army Reactor Branch we have technical people following the Army gas-cooled program. These people, that is the Army and civilian groups, get together and talk over their problems and there is mutual exchange of information. But the Army gas-cooled people are in a separate box.

The maritime gas-cooled people are in a separate box. In the Commission's organization, there is more than these four people following the gas-cooled program here in Washington. Of course, the aircraft reactors are gas-cooled reactors, or at least the direct cycle.

ADMINISTRATION OF ADVANCED PROJECTS PROGRAM

Mr. RAMEY. How are you administering your advanced or new projects program? There was a system in existence until recently that was characterized by someone at a meeting of the American Nuclear Society as a horserace, as I understand it, in which you went to the post every 6 months.

Dr. PITTMAN. I understand there have been some different characterizations of the new program. In essence, the main thing we want to change between the way the program was handled in the past and the way I want to see it handled is that instead of waiting for every 6 months to look at these things, I want to look at them as soon as somebody had an idea and came in and talked about it.

The main change that I have made is that when somebody outside—this applies only to those people on the outside who have ideas of their own. They can come in at any time and discuss it with us, either by submitting a proposal or by discussing the proposal and then submitting it if it looks like it makes sense.

I did not want to continue to wait until after we had gotten those proposals maybe as much as 4 to 6 months before making any decisions. What we have now done is to change the system to this extent: any time anybody has an idea they can come in and submit a proposal.

We can then evaluate each proposal on its merits and determine how it fits into the program. We can accept the proposal or reject it on its own merits.

We found it very difficult to make a comparative evaluation of two completely different concepts at completely different stages in the game, one of which was a minor modification of an existing concept, and the other was so new that we did not even know enough about it to make an initial study.

We now have a system set up so if somebody comes in with a modification of the water reactor schemes, we immediately send them to the water reactor people to make the evaluation to see if it fits in. If they come in with a completely new scheme, it is evaluated by Mr. Kavanagh and his people in the nuclear technology group to decide what studies and what experiments need to be carried out.

Mr. RAMEY. Isn't this growing the same way that the reactor demonstration program was originally—anybody coming in and getting a project considered and adopted. On that program you moved over to a system of designating projects in which you were interested and soliciting proposals, but always leaving room for unsolicited proposals. In your new concepts program where more than one organization has expressed an interest in a new concept—for example, this gas-cooled or steam-cooled type of reactor that the Russians are building—wouldn't it make sense to designate that as a project in which the Commission was interested, and get several outfits to make proposals and select the best one?

Dr. PITTMAN. I think this is a point of misunderstanding that should be cleared up immediately. The new concepts program is a program that consists of two phases, just as does the rest of the Commission's program; namely, that one part that we have to make the determination on our own what we want to have carried out, and leaving the door open, because we cannot say we are the only ones that

have ideas, we want to make it possible for people to come in from outside. All I talked about up to this point is how we have changed making it possible for people to come in from the outside. The Commission does have a responsibility to select new ideas that it generates, or that it thinks about in its laboratories. It has a responsibility, and we will carry it out this way, to either get the necessary work done on those projects by selection of the most capable group to do it, which can be done by public invitation or invitation to certain selected groups or whatever other techniques make more sense in a specific case.

I agree with you, Mr. Ramey, 100 percent that the Commission does have this responsibility to select new concepts, and if necessary to go out with invitations or take whatever other steps are necessary. It also has a responsbility to make it possible for those on the outside who also have good ideas to come in. That is all the horserace program ever was. I just said let us not make it every 6 months, but make it any time anybody ever has an idea.

Mr. RAMEY. I think in your last release, the general understanding was this was the only way new concepts were going to be developed.

Dr. PITTMAN. This is unfortunate, because it was not the case. I would like at least for the record here to clarify it to the extent possible.

Representative HOLIFIELD. It is no way indicates that you have given up your idea of controlling the program and directing it?

Dr. PITTMAN. Not at all, sir.

Representative HOLIFIELD. You are not letting it coast?

Dr. PITTMAN. Not at all. In the testimony in the past and in the 202 and authorization testimony, we discussed various new concept ideas that we in the Commission were thinking about. When they reach the point where they should be out as a Commission idea to go ahead, we would certainly do that. I am certainly sorry that any press release that we put out gave the impression that we were abandoning the responsibility that we feel we have.

(The letter and press release referred to follow:)

ATOMIC ENERGY COMMISSION,
Washington, D.C., March 17, 1960.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: The purpose of this letter is to inform you that the Atomic Energy Commission is changing its program for evaluating unsolicited proposals received from industry for studies of new reactor concepts.

This change disestablishes the so-called New Reactor Concepts Board which previously reviewed and evaluated the new concepts proposals, and instead places responsibility for the review and evaluation of new reactor concept proposals with the AEC organizational unit directly charged with a specific reactor program.

As you know, proposals were formerly reviewed semiannually in March and September, although proposals could be submitted at any time during the year. The revised program still provides for the submission of proposals at any time during the year, but in addition now calls for a continual review of these new reactor concepts proposals, upon receipt, by an appropriate organizational unit within the Division of Reactor Development.

The new reactor concepts program was established to assist industry and the Commission in selecting reactor systems for development. These systems may be applicable to power, heat generation, or any other industrial civilian application. This objective will be met by developing information on attractive

reactor systems to provide information for a preliminary determination of the technical feasibility of a proposed reactor system; to develop a conceptual or preliminary system design; to provide a preliminary estimate of the economic promise of a proposed system; and to define a minimum research and development program required to insure the successful construction and operation of a reactor experiment or experimental prototype.

Twelve proposals were submitted by 10 companies for the September semiannual review. As a result of this review the advanced technology laboratory of American Standard was requested to continue studies to analyze the nuclear and thermal stability of the reactor core of a mercury cooled breeder reactor. All other proposals were rejected.

A press release on this subject will be issued shortly.

Sincerely yours,

(Signed) A. R. LUEDECKE,
General Manager.

ATOMIC ENERGY COMMISSION,
Washington, D.C.

[No. C–49. For immediate release, Wednesday, Mar. 23, 1960]

AEC REVISES PROCEDURES FOR EVALUATING UNSOLICITED REACTOR PROPOSALS

The Atomic Energy Commission has revised its procedures for evaluating unsolicited proposals received from industrial firms for studies of new reactor concepts.

Formerly, unsolicited proposals were reviewed semiannually in March and September, although proposals could be submitted at any time. Under the revised procedures, proposals may be submitted at any time but they will be reviewed immediately by an appropriate organizational unit within the Commission's Division of Reactor Development.

The New Reactor Concepts Board which previously evaluated the unsolicited proposals has been abolished. The program now places responsibility for the evaluation of such proposals with the Commission organizational units directly charged with the supervision of reactor programs related to the proposed new concepts.

The new reactor concepts program was established in 1958 to stimulate the development of new reactor systems. These systems may apply to power, heat generation, or any other industrial applications. The program objectives are: to provide theoretical and experimental evidence sufficient to make a preliminary determination of the technical feasibility of a proposed reactor system; to develop a conceptual or preliminary system design; to provide a preliminary estimate of the economic promise of a proposed system; and to establish a minimum research and development program, including schedules and costs, required to insure the successful construction and operation of a reactor experiment or prototype.

Twelve proposals were submitted by 10 companies during the September 1, 1959, to March 1, 1960, review period. The Commission selected a proposal of the American Radiator & Standard Sanitary Corp., Mountain View, Calif., for continuation of studies to analyze the nuclear and thermal stability of the core of a mercury-cooled breeder reactor. All other proposals for Commission support were rejected.

The proposals were received from the following companies: American Radiator & Standard Sanitary Corp., Mountain View, Calif. (two proposals); Burns & Roe, Inc., New York, N.Y. (two proposals); Internuclear Co., Clayton, Mo.; Ford Instrument Co., Long Island City, N.Y.; Marquardt Co., Van Nuys, Calif.; Neutron Products, Inc., Washington, D.C.; Reaction Motors, Denville, N.J.; Westinghouse Electric Corp., Pittsburgh, Pa.; General Electric Co., San Jose, Calif. A proposal was also received from Paul N. Garay, Orinda, Calif.

FUEL ELEMENT DEVELOPMENT PROGRAM

Mr. RAMEY. How are you administering your fuel element development program?

Dr. PITTMAN. The fuel element development program is being administered primarily by the nuclear technology group if it is a

development program that applies across the board. We have a large amount of developmental activities in getting new fuel elements going on under the individual projects. Those would be administered by the specific branches that are handling specific projects. As you know, about a year or so ago we went out with an open invitation and got quite a few proposals on the fuel element development program. As a result of that, we have some 25 or 30 contracts underway now that cover the whole field of fuel element development.

In addition to that, our staff is constantly reviewing what is going on in the field and making determinations as to what new work we should be supporting. In general it is able to get this work carried out either in our laboratories or certain specific places where the talents are available to do a given type of work. So there is an ever-continuing amount of work going on in this field. We recognize it as probably the most important area in the reactor field right now—development of adequate fuel elements.

Mr. RAMEY. Spreading that work over 25 different contracts might again be making a rather thin program. You might be paying a great deal of overhead at 100 percent industrial rates, whereas if you had five or six contracts, you might be getting more technical work for your money.

Dr. PITTMAN. This is certainly something that has to be taken into consideration. It happens in the business of metallurgy and ceramics, which are the main things we are talking about, you go where the people and facilities are. We do have some rather large contracts, but we also have quite a few small contracts to do just this. To get where the people are that have the ability to do the job and the facilities.

Representative HOLIFIELD. Congressman Van Zandt has some questions on the military phase that he wishes to ask.

Representative VAN ZANDT. Doctor, just what does it look like from a number standpoint, that is, the military contribution to the program?

ASSIGNMENT OF MILITARY PERSONNEL

Dr. PITTMAN. In table II [p. 283], the area marked non-AEC, those totals are practically all of the military people—423 as of June 30, 1959; 450 now, and staying at about 450 over the projected time. That covers the military people in Admiral Rickover's area, General Branch's and Colonel Williams'.

Representative VAN ZANDT. That is Army, Navy, and Air Force?

Dr. PITTMAN. This is the Navy, Air Force, and the Army.

Representative VAN ZANDT. Does it involve enlisted as well as commissioned personnel?

Dr. PITTMAN. That involves all the military personnel; yes, sir.

Representative VAN ZANDT. The officers and men in training at Arco; are they involved?

Dr. PITTMAN. No, sir.

Representative VAN ZANDT. They are separate and distinct?

Dr. PITTMAN. Those people that are in training to go into the submarine service are not included in this. This includes the people that are working on the developmental programs under Admiral Rickover, General Branch, and Colonel Williams.

Representative VAN ZANDT. What is the cost to the AEC for this group of military people? I realize they are on the military payroll. Does the AEC provide administrative assistance?

Dr. PITTMAN. Could I ask somebody who might know the answer a little better? We provide them space, certainly. We provide them with the facilities to do their work. Are you speaking now at Arco, sir?

Representative VAN ZANDT. No; I am talking about the program in general.

Dr. PITTMAN. In general the military people are on the military payroll, but assigned to the AEC for operation, and therefore the space and the heat and travel is provided by AEC.

Representative VAN ZANDT. How about the secretarial help?

Dr. PITTMAN. There is quite a bit of that comes from them. If you take the one marked "military and space," this figure is 713, as of June 30, 1959, which is the number assigned to the military and space program. The portion marked "nonprofessional" are people assigned from other agencies than the AEC. This includes those people assigned to the AEC who are clerical people. You can see from the chart that the AEC does furnish a large fraction of the clerical, secretarial, and stenographic service to these joint programs.

Representative VAN ZANDT. That is all. Thank you, Mr. Chairman.

ADVANCED SODIUM GRAPHITE REACTOR EXPERIMENT

Representative HOLIFIELD. General Luedecke, on March 7 Mr. Ramey directed a letter to you in which he asked you to be ready to testify on the advanced sodium graphite reactor experiments, the design study and several other things. There are eight items in number. I think for the purpose of your comments at this time, you can take, one, two, three, skip four and five, take six, and skip the rest. Four, five, and eight will be discussed tomorrow. No. 7 has already been discussed sufficiently. That would leave one, two, three, and six, beginning with your design study for the advanced sodium graphite reactor experiment. Do you have that letter before you?

General LUEDECKE. Yes, sir; I have it right here. Dr. Pittman will comment on them.

(The letter referred to follows:)

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
March 7, 1960.

Gen. A. R. LUEDECKE,
General Manager,
U.S. Atomic Energy Commission,
Washington, D.C.

DEAR GENERAL LUEDECKE: Confirming earlier staff discussions in connection with the Subcommittee on Legislation's consideration of the AEC authorization bill it would be appreciated if the Commission would prepare a statement, or be prepared to testify, on the following possible additional projects. The Commission's explanation should indicate both the advantages and disadvantages of proceeding with such projects.

1. Design study for advanced sodium graphite reactor experiments

As will be recalled, both the Commission's plans and the Joint Committee staff study of a year or two ago indicated that it would be desirable to go ahead with an advanced SRE experiment in 1960 or 1961, prior to the operation of the Hallam reactor. It was recognized then and now that no advanced prototype

would be designed or constructed until after the Hallam prototype went into operation.

2. Design study for a "steam cooled" reactor

As you know, the Joint Committee staff study contemplated a steam cooled reactor experiment in 1960 or 1961. It is understood also that the Commission as well as several equipment companies and utility groups, has been studying such a concept. Thus, for example, the Nuclear Power Group has been considering a reactor of this type involving a graphite-moderated boiling and superheating reactor. It is understood that other reactor designers have been following the Russian type graphite-moderated reactor of the same general type.

In view of the fact that no private group seems to be proceeding with this study and because of its inherent promise, should not the Commission proceed with a full scale design study?

3. The so-called spectral shift reactor prototype

It is noted that the Commission indicates that it may want to proceed with a prototype spectral shift reactor if the organic prototype is constructed under the third round program, thereby freeing the $25 million of funds requested for 1961 for this purpose. This would indicate that the problem with the spectral shift reactor may be more budgetary than technical.

4. Civilian type reactor for remote location such as Guam

It is noted that the Commission requested this project but was turned down by the Bureau of the Budget. More information on this project should be available in the AEC report due April 1.

5. Small portable type reactors for remote locations, such as the Antarctic

It would appear that package power reactors would be economic for Antarctic bases. Therefore such plants should be very attractive.

6. Industrial process heat reactor

It is recognized that a process heat reactor has been authorized which is being constructed in conjunction with the saline water project. However, it is quite possible that industrial applications of nuclear process heat, such as in chemical plants, paper mills, etc., may also offer great advantages for process heat. Accordingly, an additional project to demonstrate the technical and economic advantages of such a reactor may be desirable.

7. The natural uranium, heavy water prototype

It is noted that the Commission put in $55 million to design and construct this prototype for 1961 but this was removed by the Bureau of the Budget. It is recognized that the Commission proposes now to engage in full-scale cooperation with the Canadians in their prototype reactor design and construction. The question arises, however, whether or not sufficient technical experience and know-how will be obtained in this country on this concept without the construction in the United States of a natural uranium, heavy water prototype.

8. Atomic powerplant for a tanker

The initiation of detailed design and construction of a tanker nuclear propulsion system of advanced design based on the latest technical information to take advantage of cost reductions may be indicated.

In addition to atomic power projects, it was indicated that the subcommittee would probably be also interested in emphasizing the following projects in its consideration:

1. Rover project. (Nuclear power for outer space propulsion.)
2. SNAP project. (Auxiliary power for space vehicles.)
3. Food irradiation project. (The need for a national program and facilities.)
4. Status of test reactors.
5. Stanford accelerator project.

It is recognized that not all of these projects can be taken up during the period of March 8–10, and such projects such as the Stanford accelerator, remote sites and food irradiation, will have to be considered in detail during the April hearings. Other projects of interest to Joint Committee members will also be considered.

Sincerely yours,

JAMES T. RAMEY,
Executive Director.

Representative HOLIFIELD. It does not make any difference who testifies on it.

Dr. PITTMAN. The situation with regard to the point that is raised, design study for advanced sodium graphite reactor experiment, was covered in our 10-year program, on the basis of the information that was available to us at this time, recognizing that the sodium cooled or the metal cooled reactor concept has great potential advantages for the long range future of civilian programs, as well as for other programs, but further recognizing that the fast reactor systems have all of the advantages or seem to have on the basis of our present knowledge, of the sodium cooled system, and in addition, give the potential for high conversion ratios or even for possible breeding. In the face of this situation, namely, that the sodium thermal system, and this is what we talk about in the advanced sodium graphite which is a moderated system, that it seems to offer nothing that the fast system does not offer, recognizing that we have two reactors, the Hallam reactor being built, and the SRE that will be back in operation on the system, we feel it is not timely to construct another sodium graphite experiment. You will recall in our 10-year program we did predict that in the event that either the Hallam operation if combined with SRE proves to be more favorable than we are able to calculate now, or in the event the solution to the problems of the fast reactor systems are not as favorable as we think they would be, we would in those cases go back to the construction of the epithermal systems. At that time it would be worthwhile to build an experiment and possibly a large scale reactor.

In the meantime, however, we will be doing practically all of the experimental work that has to be resolved before we carry on with the thermal system, namely, carry on with the sodium component test work that has to be done. We are charging the program to the fast reactor system.

Mr. RAMEY. You cut out your sodium component test facility, though, of $3.2 million.

Dr. PITTMAN. I was going to answer that just before you asked it. There was in the budget a figure of $3.2 million for a sodium component test facility We have as you know undertaken a rather careful study of the available facilities we have around the country. This study has been complete. While we have not yet completely analyzed it, it looks like we can do everything that needs to be done, and should be done in the sodium component work without the construction of this facility at this time. Later on we may need this facility. Although we have not completely finished the analysis, I think I can say that not having this $3.2 million facility will not hold up the development program in the sodium systems.

Representative HOLIFIELD. You think there is a need for a design study?

Dr. PITTMAN. I think it is not only not necessary, but it would probably take a lot of time. We can make an improvement on the Hallam design but it would not be the improvement we ought to make if this system is really to come into its own. Then the question of whether it should come into its own, I think, must depend on whether the fast system comes in.

Representative HOLIFIELD. Does that mean you are going to wait until the Hallam facility has operational experience of at least a year?

Dr. PITTMAN. Our plan is to go ahead with the construction of the Hallam facility, carry on with the SRE work, and more importantly to develop a fuel element that can offer some potentials in this sodium system. We think the carbide fuel element is the one that will make sense in that. This means that the decision to do anything in additional sodium thermal reactor experiments would probably not be made until after Hallam had been in operation for maybe on the order of a year, unless prior to that time the experimental work that is going on in the fast sodium system proves to be so solid that it looks like there is no future in that or we have completely missed the boat on that. In that case I think we would pick up the sodium thermal or more likely the epithermal system and not go all the way to the large graphite moderated reactors. The SRE reactor at Santa Susana certainly lends itself to modifications to carry out some of the experimental work that will be necessary in this field. But more importantly I think we can get more information about the major engineering problems of this system without doing it in a reactor system. Once you build a reactor system, you pretty well freeze what you can do in the flexibility of the engineering of that system.

Representative HOLIFIELD. The Atomics International people were pretty enthusiastic about going ahead and not waiting until the Hallam reactor was constructed. Their testimony before us was quite enthusiastic.

Dr. PITTMAN. I am glad to hear they are enthusiastic because that is a thing they are doing for us. I hope they stay enthusiastic. I have had discussions, however, and I don't know whether it was before or after Dr. Starr talked to the committee, with him about this and I believe Dr. Starr is in agreement with the program that we are proposing to carry out. I think he agrees with me that the determination of the engineering problems can be done without building the reactor and the most important thing is getting this fuel element problem solved.

STEAM-COOLED REACTOR

Representative HOLIFIELD. Let us go to the design study for a steam-cooled reactor.

Dr. PITTMAN. This particular steam-cooled reactor study was made by Atomics International for the Nuclear Power Group, which is the group involved in the Dresden reactor. This study was made with private funds entirely. The Commission was not involved in it. The study was made available to the Commission. This reactor has some potential advantages that certainly are worth looking into. One of the big advantages is that the coolant—that is, the water or the steam—never comes in contact with the fuel elements, and therefore the steam that leaves the reactor has no possibility of being contaminated. This is one of the problems that has worried people in the boiling water system, for instance. It is the transfer of heat from the fuel element to the steam by radiation through the graphite. This is a concept that certainly has a lot of unknowns. There has been no experimental

program run. What we have done on this is to review the study made by AI for NPG. We have a small contract with AI now, the results of which should be available to us in mid-June. One of the things that we asked in the study, in addition to making a study of what kind of experimental program would be necessary to prove out the uncertainties of this program and to give us the information necessary to go ahead, is to make a study of a slight modification of this system in which instead of using graphite as the block—this is just really a big graphite block which has holes in it—that they use zirconium hydride. They are making a comparative analysis of that. I think when these studies are in, we will certainly be in a much better position to make a decision on the part of the Commission as to where it does fit into our future program. It very definitely has some potential advantages. Its disadvantages are equally obvious. It is a large reactor with low specific power. It is a question of whether the advantages will overbalance the disadvantages.

Mr. RAMEY. One question on the administration of this. I believe you mentioned earlier that there may be variations on this type of design. We have had recommendations as far back as 1956 on steam-cooled reactors or reactors of the type that the Russians were contemplating. Wouldn't this be the type of a project that you might want to solicit proposals from various reactor designers and make a selection rather than just selecting one outfit that walked in the door?

Dr. PITTMAN. Yes. I think it might well be at two points. You might get additional information because there are other people who have ideas in this field. We talked to these people several years ago. I think they talked to the Joint Committee about this. No proposals were forthcoming at that time, even though we asked for the gentlemen involved to submit proposals. I think as a result of the initial studies it may well be that we will want several programs going on in the same field to be sure that there is adequate coverage. Certainly when you get to the point of talking about construction of prototypes and things like that, it would have to go into some sort of open and broad competitive-type operation.

I would like to correct one thing, Mr. Ramey. This is not the type of reactor the Russians are building. The Russians have a graphite-moderated steam-cooled reactor, and it does not have the features of this one that make the water and superheat the steam in channels that have no fuel in them.

Mr. RAMEY. I meant it as a variation of the Russian type.

Dr. PITTMAN. It is so much of a variation that I would like to consider it as sort of a separate unit. Let us take credit for this one separately.

Mr. RAMEY. This is not the Huntington type of reactor?

Dr. PITTMAN. Mr. Huntington, as I recall, several years ago talked to both the Joint Committee and other Members of Congress, and to the Commission, about a large block of graphite in which the cooling was through radiation. So you can say the idea is the same as the one Mr. Huntington talked about.

SPECTRAL SHIFT REACTOR PROTOTYPE

Representative HOLIFIELD. The next item is the so-called spectral shift reactor prototype. We keep hearing about this as the possible use of this $25 million fund in case the organic prototype is constructed under the third round.

Dr. PITTMAN. The spectral shift is an idea that may have merit. I won't try to go into the details of what it is. In essence it is a way of giving you some control of the neutrons that are produced in a reactor that has a large amount of excess fuel as you have to have in reactors when they first start. You have to have enough fuel so it will run for a long period of time. By varying the concentration of the heavy-light water mixture in the reactor, you vary the speed of neutrons. You change the moderation. By changing the moderation and the speed of the neutrons you vary the number that go into causing more fissions or go into absorption of U^{235} to make plutonium. So by proper control of the ratio of heavy to light water you are able to essentially store these neutrons that otherwise you would have to absorb in poisons to form plutonium which later on as the U^{235} is burned out becomes available for subsequent burnings. This gives you a way of control and it gives you a way of flattening the reactor that certainly has some potentials that must be looked into.

It looks like the first step is to carry out an experimental program including a critical assembly to find out some of the nuclear characteristics of the system.

We have asked B. & W. who were the generators of this idea, so to speak, to give us a proposal on the experimental program that is needed to carry this out. In our opinion it is necessary to carry out a program of about a year to a year and a half before a decision could be made to move forward in this. It may be that the experimental results will come in quicker and that is one of the reasons that this one was put in as a possible contender for the $25 million in the event that the organic did not come in. It looks right now that there is at least a year's experimental program before you make a decision to move into the construction of a prototype.

Representative HOLIFIELD. This is about the first time we have heard about this. This has not been proposed by any outside group.

Dr. PITTMAN. This came in as an idea that the Babcock & Wilcox Co. has been sponsoring and proposing to push.

Representative HOLIFIELD. Have they done any preliminary work in research?

Dr. PITTMAN. They have done some preliminary caculations. Whether they have done anything else, I will have to ask. Mr. Staebler informs me that mostly it has been caculations, which is what I thought. But some small amount of experimental work at Lynchburg in their own experimental facilities.

Representative HOLIFIELD. This is pretty much in the land of theory.

Dr. PITTMAN. Yes.

Representative BATES. Where did you get the name?

Dr. PITTMAN. The energy of the neutrons that is released varies depending upon whether they are slow or fast, and it is called the spectrum, and this shifts the spectrum so it is called the spectral shift.

INDUSTRIAL PROCESS HEAT REACTOR

Representative HOLIFIELD. Now we get back to the industrial process heat reactor. We have never been able to get anyone interested in this in industry, have we?

Dr. PITTMAN. The situation on the industrial process heat is that we have underway now these discussions with the Department of the Interior to get this desalinization program and a reactor process heating program being carried out simultaneously. Over the years and over the past few years there have been one or two groups from industry who have come in to us and suggested that we build a reactor for the purpose of producing steam for use in some industrial effort. We have not issued any invitations under which we have stipulated the conditions where such a cooperative program could be carried out.

Mr. RAMEY. The law did provide for that last year.

Dr. PITTMAN. Yes; that is right. The reactor that we have is a line item reactor with the authority to build it cooperatively either with another Government agency or industrially. The program we are now carrying out is a cooperative program with the Department of Interior.

Mr. RAMEY. I think it is arguable that while your project with the Department of Interior is desirable, that an industrial outfit like a paper company or chemical outfit will never really believe they can use process heat unless somebody builds a process heat reactor attached to an industrial plant, rather than to a developmental saline water plant.

Dr. PITTMAN. It is certainly arguable in this direction. As we discussed the other day, Mr. Ramey, I believe it is perfectly true that the demonstration of process heat produced in a reactor can be equally well done whether you are dumping the steam or whether you are using it to furnish heat to evaporate salt water or whether you are using it in the paper industry to dry the pulp or in any other way. I would agree with you that the people who will use it in the paper industry probably want the demonstration made in the paper industry's plants.

Representative HOSMER. Mr. Chairman, I think we had a man come down from Michigan who had to have more steam but he wanted you to put up the reactor and sell him the steam for essentially less than it would cost him to put in a capital investment for producing it himself. There was no real burning desire for the steam to come out of the reactor except that they could get it for less.

Dr. PITTMAN. We could get the reactor in a competitive-type industry where the cost of steam is a highly important factor in this profit and loss column. I think there may be conditions under which it could be done, but it would certainly offer some serious administrative problems as to how it should best be done.

Representative HOSMER. As a matter of fact, you probably have in Weinberg's file 75 reactor ideas that look just as good as the comments in the letter of March 7, have you not?

Dr. PITTMAN. We have quite a few ideas that we are looking at, and evaluating, and we are hopeful that some of them will go rather quickly into experimental basis.

Representative HOSMER. You have an almost endless number of people coming up with ideas for different reactors.

Dr. PITTMAN. That is right.

Representative HOSMER. You just have to draw the line somewhere.

I did want to ask you a question about this 10-year program.

If one of those types suddenly emerges as a real economic reactor, that will throw the rest of the program out?

Dr. PITTMAN. Certainly if one reactor produces steam at a very low cost of 4 or 5 mills, it would have a serious impact on the program. My own opinion is that it will not work that way. There will be different reactors that will fit into different size ranges and certainly the program for the military will be different from the civilian requirements.

Representative HOSMER. But it will certainly make a whale of a difference how much industry money will come in.

Dr. PITTMAN. That is right.

Representative HOSMER. If they can get something that is economical they will not fool around with a lot of experimentation. In the last series of hearings on this when we got down to the cost factors, we were not pushing more than 2 or 3 mills difference then with the most exotic idea that we had proposed.

Dr. PITTMAN. In the time scale we were talking about, this is true.

Representative HOLIFIELD. Are there any other further questions on this? Then we will conclude the hearings today and meet tomorrow morning in room 3110 in the New Senate Office Building, and we will go into the nuclear tanker and remote sites, and the Stanford electron accelerator, and other high energy projects. We may have to make arrangements for a room in the afternoon. We are having trouble getting rooms for our hearings. We have an important controversial matter on the floor tomorrow afternoon, and it will be pretty far for the members to go to the New Senate Office Building and make their rollcalls. So we will announce the afternoon hearing room at noon. In the morning we will have it in room 3110, New Senate Office Building, at 10 o'clock.

(Thereupon at 3:45 p.m., Tuesday, April 5, 1960, a recess was taken until Wednesday, April 6, 1960, at 10 a.m., in room 3110, New Senate Office Building.)

AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1961

WEDNESDAY, APRIL 6, 1960

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON LEGISLATION,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10 a.m., in room 3110, New Senate Office Building, Hon. Chet Holifield, chairman of the subcommittee, presiding.

Present: Representatives Holifield, Price, Van Zandt, Hosmer, and Westland; Senators Anderson, Jackson, and Dworshak.

Also present: James T. Ramey, executive director; David R. Toll, staff counsel; Edward J. Bauser, technical adviser; and Bernard V. Dvoskin, GAO consultant.

Representative HOLIFIELD. The subcommittee will be in order.

The Subcommittee on Legislation is continuing its public hearings this morning on S. 3084 and H.R. 10656, bills to authorize appropriations for the AEC for fiscal year 1961.

This morning we plan to hear testimony concerning the design studies authorized by section 113 of Public Law 86–50, the AEC Authorization Act for the current fiscal year 1960.

First, we will hear a report from the AEC and from the Maritime Administration concerning the design studies for a prototype reactor for a nuclear tanker. Representatives of the contractors who performed the design studies have also been invited to be present and comment briefly orally if they so desire.

Secondly, this morning we hope to hear the report on the design studies for reactors for remote military installations, including possible use of atomic power plants at McMurdo Sound, Byrd, and South Pole stations in the Antarctic.

This afternoon, the subcommittee will receive testimony concerning the proposed linear electron accelerator at Stanford University and other high energy physics projects.

I would like to announce a change in the hearing room for this afternoon. We have been able to obtain room P–63, the old Supreme Court Chamber, and therefore the hearing will be held in room P–63 of the Capitol, rather than in this room, commencing at 2 p.m., this afternoon.

(By letters dated April 1, 1960, the AEC transmitted to the committee proposed amendments to the authorization bills as follows:)

ATOMIC ENERGY COMMISSION,
Washington, D.C., April 1, 1960.

HON. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: I have transmitted today to the Speaker of the House of Representatives and the President of the Senate proposed amendments to S. 3084 and H.R. 10656 which would (1) authorize appropriations to be made to the Atomic Eenrgy Commission in the amount of $107,200,000 for the construction of a linear electron accelerator, together with the necessary buildings and appurtenances thereto, and (2) amend the amount of appropriations for which authorization is requested for certain other projects.

Forwarded herewith are copies of the proposed amendments, the analyses of these amendments, and the related project data sheets.

There is also attached a revised project data sheet and project analysis for project 57–d–1, zero gradient synchrotron, Argonne National Laboratory, Illinois, which reflects the somewhat curtailed scoping now planned for that project.

Sincerely yours,

JOHN A. MCCONE, *Chairman.*

AMENDMENTS PROPOSED TO S. 3084 AND H.R. 10656

1. Section 101: Plant or facility acquisition or construction, page 1, line 7, strike "$171,256,000" and insert in lieu thereof "$293,876,000".

2. Section 101(c): Atomic weapons, page 2, lines 21 and 22, strike "Project 61–c–1, Tonopah Test Range, Tonopah, Nevada, $1,900,000." and on page 2, line 23, strike "61–c–2" and insert in lieu thereof "61–c–1".

3. Section 101(f): Physical research for project 61–f–2, Princeton-Pennsylvania accelerator addition, Princeton, N.J., on page 4, line 9, strike "$1,350,000" and insert in lieu thereof "$10,820,000".

4. Section 101(f): Physical research (for project 61–f–3), accelerator and reactor additions and modifications, Brookhaven National Laboratory, New York, on page 4, line 12, strike "$1,285,000" and insert in lieu thereof "$1,085,000".

5. Section 101(f): Physical research (for project 61–f–5), accelerator improvements, Lawrence Radiation Laboratory, California, on page 4, line 16, strike "$950,000" and insert in lieu thereof "$500,000".

6. Section 101(f): Physical research (for project 61–f–6), on page 4, line 17, strike "bevatron shielding" and in lieu thereof insert "major bevatron improvements", and on page 4, line 18, strike "$1,100,000" and in lieu thereof insert "$9,600,000".

7. Section 101(f): Physical research, on page 4, immediately following line 18, add "Project 61–f–7, linear electron accelerator, $107,200,000."

61–f–2. Princeton-Pennsylvania accelerator addition, Princeton, N.J., $10,820,000

This project provides for construction of a new administrative, maintenance, and laboratory wing, new storage building, an external beam room with necessary facilities, and of an extension to the meson experimental area.

The new wing will be a building designed to house the operating and maintenance staff, purchasing department, machine shop, administrative staff, and some of the laboratories and experimental facilities. The storage building will be a single-story building for receiving, storing, and handling of research equipment temporarily set aside, and supplies for the accelerator project. The external beam facilities will consist of several structures, including (1) an underground bombardment room; (2) a combination one- and two-story building designed to house external beam room supporting facilities; (3) a water cooling tower designed to handle the cooling requirements of the external beam room and supporting facilities; and (4) an addition to the present substation facility. The meson area extension will consist of a curved building surrounding and matching the present meson area. All buildings or additions will be located on long-term leased or purchased land.

A new wing is needed because the present office and laboratory building is already 100 percent occupied by accelerator engineering staff, administrative staff, and supporting functions. Part of the accelerator staff is housed 3 miles away on the main campus and should be moved over to the accelerator building as soon as possible.

A new storage building is needed since at the present time there is no storage area available of sufficient size to store bulk materials and auxiliary equipment temporarily not in use.

Extension of the meson area is needed because recent developments in high energy physics show that the presently planned meson area is inadequate to carry out the types of experiments the state of the art now permits.

The original Princeton-Pennsylvania proposal of December 1955 discusses the future need for an external beam facility. This facility could not be adequately defined in 1955, but can now be specified. Certain classes of experiments cannot be performed with the presently planned internal proton beam. Experiments such as proton scattering, study of direct proton interactions using bubble chambers, and detection of very short-lived particles would be practicable only with a well-shielded external proton beam.

61–f–3. Accelerator and reactor additions and modifications, Brookhaven National Laboratory, New York, $1,085,000

This project provides for recurring annual projects of varying magnitude to take care of inevitable necessary changes and additions to the major research machines at Brookhaven: the graphite reactor, the cosmotron, and the alternating gradient synchrotron. In general, this type of item cannot be established in all details in advance.

Tentative plans for fiscal year 1961 include the following:

Research reactor filters.—This project provides for more efficient filters in the air exhaust ducts system of the research reactor. This filter changeover has been suggested by the Hazards Evaluation Committee.

Cosmotron.—The new experimental facilities of this accelerator make possible new types of experiments and a multitude of secondary and primary particle beams. These require a large number of focusing and deflecting magnets. Power supplies for many of these magnets will have been acquired in previous years. Some additional sets will be required in fiscal year 1961. New straight sections are necessary for both operational and experimental reasons. These new straight sections will be larger and thus provide considerably better experimental facilities; furthermore, they will be designed to improve mechanical stability at the ends of the quadrants.

Alternating gradient synchrotron.—This project will provide for beam separators, power distribution, and switchgear for experimental equipment, experimental power supplies, 2 megawatts (rotating equipment only; rectified power supplies on trailers are included in capital equipment budget), fixed steel and concrete shielding.

61–f–5 Accelerator improvements, Lawrence Radiation Laboratory, California, $500,000

This project provides for improvements and additions to the 184-inch cyclotron and the heavy ion linear accelerator. The requested improvements and additions are primarily of an experimental nature, involving a varied application of engineering design and equipment usage, including equipment installation for varying periods of time.

An accelerator improvements project was first requested for fiscal year 1958 as part of a project extending over 3 years at a total requested level of $2,200,000. An appropriation in the latter amount will be fully committed and substantially expended by the end of fiscal year 1960. Although construction funds for accelerator improvements will be nearly depleted by the end of fiscal year 1960, programmatic developments have determined a need for a continuous accelerator improvement activity. The effectiveness of accelerators cannot be realized in their full scientific potential without continuous modification to maintain the pace of physical and technological advancements.

61–f–6. Major bevatron improvements, Lawrence Radiation Laboratory, California, $9,600,000

The effectiveness of the present bevatron research program is limited by three shortcomings of the facility; limited beam intensity, restriction in the number of experiments which can be performed simultaneously, and reliability in the overall operation of the facility. This project will provide for increased beam intensity, increased bevatron experimental facilities, new external beams, both primary and secondary, and increased reliability and flexibility of bevatron operation.

This major bevatron improvements program has been under consideration for some time and the types of modifications requested have been thoroughly studied.

The total estimate indicated here is considered to be of the correct order of magnitude, and only the details are expected to be subject to appreciable variance. The basic concepts of increasing the beam intensity, expanding the experimental facilities and insuring greater facility reliability are not expected to change.

The bevatron is scheduled for some 30 major experiments per year. The average time for each experiment is about 1 month. Usually three or four experiments are set up simultaneously. In many cases these share the available scheduled operating time of 160 hours per week. In some cases it is possible to run two experiments simultaneously on a beam-sharing basis.

At the present time the scheduled bevatron research program extends nearly a year into the future. Other proposed experiments would add at least another year, were they scheduled at this time. This leadtime is a grave situation for a research program in fundamental science. This is made clear by the rapid developments in experimental techniques made in recent years. The development of mass spectrometers suitable for high energy particles has led to increased demands on beam intensity, because higher beam intensity makes possible increased proportions of the extremely rare particles of the beam such as antiprotons and K mesons.

The improvement program is justified in terms of an increase in the amount of scientific research which will be done at the bevatron. Each item in the program is directed toward this end.

61–f–7. linear electron accelerator, $107,200,000

This project provides for the design and construction of a high energy electron accelerator at Stanford University. The description set forth below represents present planning for this machine and associated support facilities. Definitive design of the machine and technological development during the design and construction period may necessitate some changes in the project.

The machine will be of linear design approximately 2 miles in length, and in the initial stages will achieve an energy range of 10 to 20 billion electron volts. Design and construction of the machine and associated facilities will require approximately 6 years beginning in fiscal year 1961.

It is planned that the accelerating tube will be contained in a housing 12 feet wide which will be deep enough in the ground to provide the necessary radiation shielding. A parallel, surface-level housing, 16 feet in width, will contain the klystrons and associated equipment. The two housings are to be separated by 35 feet of earth so that personnel can service the equipment while the accelerator is in operation.

The accelerator will be powered by 240-klystron amplifiers. Initial operation of each klystron is planned at 6 megawatts, giving an electron beam of 10 billion electron volts. With present-day techniques the klystron power may be increased to give a beam of 20 billion electron volts.

The accelerator and klystron housings, waveguides, accelerator tube, and power facilities are being planned so that at a later date the beam energy can be further increased to 45 Bev. should this become desirable in the future.

The proposed electron linear accelerator will provide at 10 to 20 billion electron volts the highest energy electron beam in the world. Its average current of 15 microamperes is substantially higher than can be attained with a circular machine.

The beam is easily extracted and its small angular divergence makes possible great precision in experiments. An accelerator with these characteristics has been strongly recommended by a special panel of the President's Science Advisory Committee and the General Advisory Committee to the Atomic Energy Commission, and approved by the President.

It is presently planned that the accelerator will be build on land owned by Stanford University. Appropriate arrangements, including a long-term lease of the land will be negotiated between the Atomic Energy Commission and Stanford University.

Section 107: Project 57–d–1. Zero gradient synchrotron, Argonne National Laboratory, Illinois

This project provides for the design and construction of a high intensity high energy proton synchrotron (approximately 12.5 Bev.) and related laboratory and experimental areas at the Argonne National Laboratory. A high energy accelerator project was authorized in fiscal year 1957 (project 57–d–1) for $15 million. The justification for that project was made on the basis of an urgent short-range need for extending the energy range beyond that of presently avail-

able machines. The site and specifications for the machine were undetermined at the time of its authorization.

Subsequent to the authorization of that project, the Argonne National Laboratory was selected as the site for this machine and a study was conducted to determine what type of an accelerator could be built for $15 million. It was found that any accelerator built for this amount would be essentially a duplication of an existing machine or one already under construction in the United States. Accordingly, the desirability of constructing such a machine was reconsidered, especially in light of the fact that the National Science Foundation's Advisory Panel on High Energy Accelerators had recently recommended that first priority be given to those machines that give promise of extending the important accelerator parameters to new ranges. As a consequence, it was decided to increase the authorization for this project to $27 million in the fiscal year 1958 authorization act. The last cost estimate submitted to the Congress was $29 million included in the fiscal year 1960 congressional budget submission.

Work has proceeded under the fiscal year 1958 authorization, and as of February 29, 1960, design was 60 percent complete and construction was 17 percent complete. A recent review of the project has been made, and it has been determined that certain high energy facilities associated with the machine should be provided now and the scope increased. These additional facilities need to be constructed simultaneously with the basic project in order to utilize as soon as possible more of the machine's potential for making significant contributions in the field of high energy physics. Construction of these facilities now would also avoid serious interference with the operation of the machine that would occur if these items were to be delayed. An increase in the authorization to a total of $42 million is requested.

The increase will provide for significant additions to the experimental facilities and related power supplies, cooling systems, and machine controls. Also included are relatively minor improvements to the operating capabilities of the synchrotron. The major items of these additional facilities are: modifications to the meson shield wall, an external experimental proton area, power building for the meson area and proton area, cooling system additions, additions to the main substation, additions to the main power building, additions to the shop and assembly building, site improvements and utility extensions, a bubble chamber building, and a cryogenics facility.

This project will provide a much needed high energy accelerator in the Midwest at an energy and intensity not otherwise available in the United States. The proposed machine will provide a copious source of antiprotons and antineutrons and will thus open the whole field of "antimatter" reactions for precise experimentation. The bevatron has permitted the discovery of these particles but its energy range is too low for their production on a scale for precise experimentation. The intensity of the machine will be capable of producing a beam containing 10^{13} particles per minute which is greater by a factor of 15 or 20 than that expected to be produced by the alternating gradient synchrotron now under construction at the Brookhaven National Laboratory.

ATOMIC ENERGY COMMISSION,
Washington, D.C., April 1, 1960.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: Forwarded herewith are 25 copies of a revised project analysis sheet for project 61–f–3, accelerator and reactor additions and modifications, Brookhaven National Laboratory, New York. These revised sheets are to replace page 29 in the classified and unclassified analyses documents dated February 12, 1960, which have been previously furnished to the Joint Committee on Atomic Energy. Also forwarded, and relating to the same project, are three copies of revised pages 96, 97, and 98 for substitution for similarly numbered pages in the document "Fiscal Year 1961 Plant Acquisition and Construction, Program To Be Authorized, Construction Project Data Sheets" dated February 15, 1960, and previously forwarded.

The analysis sheet and data sheets for project 61–f–3 are being revised to remove the indication that included in the tentative plans for fiscal year 1961 are hydrogen safety devices and houses (movable) for experimental equipment in the uncovered experimental areas. Sufficient funds have been determined to be

available under the current construction project for the alternating gradient synchroton to provide for hydrogen safety devices, and a covered experimental area for experimental equipment in lieu of the movable houses as previously planned. The estimated cost of project 61–f–3 has been reduced by $200,000 to $1,085,000 to reflect the above changes.

Sincerely yours,

A. R. LUEDECKE, *General Manager.*

REVISIONS TO ANALYSIS OF PROPOSED BILL FOR AUTHORIZATION OF APPROPRIATIONS UNDER SECTION 261 OF THE ATOMIC ENERGY ACT OF 1954, AS AMENDED, FISCAL YEAR 1961

61–f–3. Accelerator and reactor additions and modifications, Brookhaven National Laboratory, New York, $1,085,000

This project provides for recurring annual projects of varying magnitude to take care of inevitable necessary changes and additions to the major research machines at Brookhaven: the graphite reactor, the cosmotron, and the alternating gradient synchrotron. In general, this type of item cannot be established in all details in advance.

Tentative plans for fiscal year 1961 include the following:

Research reactor filters.—This project provides for more efficient filters in the air exhaust ducts system of the research reactor; this filter changeover has been suggested by the Hazards Evaluation Committee.

Cosmotron.—The new experimental facilities of this accelerator make possible new types of experiments and a multitude of secondary and primary particle beams. These require a large number of focusing and deflecting magnets. Power supplies for many of these magnets will have been acquired in previous years. Some additional sets will be required in fiscal year 1961. New straight sections are necessary for both operational and experimental reasons. These new straight sections will be larger and thus provide considerably better experimental facilities; furthermore, they will be designed to improve mechanical stability at the ends of the quadrants.

Alternating gradient synchrotron.—This project will provide for beam separators, power distribution and switchgear for experimental equipment, experimental power supplies—2 MW (rotating equipment only; rectifier power supplies on trailers are included in capital equipment budget), fixed steel and concrete shielding.

STATEMENTS OF JOHN F. FLOBERG, COMMISSIONER; DR. ROBERT WILSON, COMMISSIONER; GEN. A. R. LUEDECKE, GENERAL MANAGER; DR. FRANK PITTMAN, DIRECTOR, DIVISION OF REACTOR DEVELOPMENT; DR. JOHN H. WILLIAMS, COMMISSIONER; DR. PAUL W. McDANIEL, ACTING DIRECTOR, DIVISION OF RESEARCH; COL. D. G. WILLIAMS, ASSISTANT DIRECTOR FOR ARMY REACTORS, DIVISION OF REACTOR DEVELOPMENT; R. P. GODWIN, ASSISTANT DIRECTOR FOR MARITIME REACTORS, DIVISION OF REACTOR DEVELOPMENT, ATOMIC ENERGY COMMISSION

Mr. FLOBERG. Mr. Chairman, we are prepared to discuss the subjects this morning. General Luedecke will open the presentation.

Representative HOLIFIELD. You may proceed.

DESIGN STUDIES FOR PROTOTYPE REACTOR FOR NUCLEAR TANKER

General LUEDECKE. Under the provisions of section 113 of Public Law 86–50, the Commission proceeded with three design studies for nuclear reactors for tankers. The boiling water reactor concept, direct cycle natural circulation, prepared by the General Electric Co., the boiling water reactor indirect cycle by the Westinghouse Corp.,

and the pressurized water reactor advanced by Combustion Engineering. The Commission made an evaluation of these studies which was transmitted to the committee by letter of transmittal from the Commission on the 1st of April.

(The letter referred to follows, together with pertinent portion of the report:)

ATOMIC ENERGY COMMISSION,
Washington, D.C., April 1, 1960.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: The Commission is delivering herewith copies of reports on three design studies of a prototype reactor for a nuclear tanker. This work was done in response to section 113 of Public Law 86–50, in cooperation with the Maritime Administration of the Department of Commerce.

While a tanker was chosen as the reference vessel, it was intended in these studies to identify a prototype nuclear propulsion plant suitable for relatively early, and in later year, broad application to the merchant marine. Further, it was desired to identify a nuclear system amenable to major improvements in efficiency, simplification, and automation. This work was not aimed at identifying the most promising ship or trade route in which to employ such a nuclear system if a ship construction program was authorized.

In a like manner, the fact that the studies indicate that, from an economic standpoint alone, the BWR appears to be slightly more attractive than the PWR, should not be interpreted to mean that the Commission is taking a position that the former system would be the most suitable for maritime propulsion use. Factors such as relative state of the development of the systems, conditions to be met in ship operation, reliability of operation, schedule of needs, etc., must be considered along with potential economics in deciding what reactor system is best suited for a specific marine use.

Under the assumptions employed, the evaluation report contains conclusions which are generally supported by the data developed and reported in the various sections of the report. While the cost information contained in this report was developed in accordance with current practice in preparing competitive proposals, it should be emphasized that the Commission does not regard this information as representing guaranteed prices, since it was based on vendors' estimates and not on bids. For this reason, and in view of the many factors, such as today's depressed maritime market, which influences the maritime aspects of the study, we caution that costs shown in the study be considered as comparative only and not as absolute.

One of the referenced trade routes employed, Persian Gulf to U.S. east coast, was studied principally to demonstrate the improved position of nuclear power in ships of high speed on long trade routes. In commercial practice, a route such as this is served by foreign ships except in instances where there is a shortage of ocean transportation. Foreign-flag ships also establish the competitive transportation rate. The second case studied, Gulf of Mexico to U.S. east coast, is more typical of the service in which U.S.-built tankers would normally operate and results in poorer economic performance of the nuclear tankers as compared with conventionally powered tankers on the same trade route.

The Commission is prepared to discuss the results of these studies in detail at your convenience.

Sincerely yours,

A. R. LUEDECKE, *General Manager.*

INTRODUCTION

This document reports on the findings of an evaluation group convened to consider three nuclear powered tanker design and engineering studies carried out in accordance with Public Law 86–50.

These studies were conducted to review water reactor technology in order to determine the relative merit of the various water reactor propulsion concepts which could be applied to a tanker and their potential to achieve economic operation in the relatively near future.

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In these studies, the Maritime Administration provided the naval architectural and marine engineering portions of the work and advised the Commission that the most suitable practical ship for reference purposes would be a 43,000-deadweight-ton tanker. In addition, the Maritime Administration developed a conventional ship design based on the same assumptions as the subject studies and established construction and operating costs estimates on the basis thereof. These results are presented in this report for comparative purposes.

While the tanker was chosen as the reference vessel, it was intended in these studies to identify a nuclear propulsion plant suitable for early and broad application to the merchant marine. Further, it was desired to select a system amenable to major improvements in efficiency, simplification, and automation.

A description of the major assumptions and general design data furnished to the contractors for the reference tanker is given in appendix A. These instructions to the contractors also included the formats for reporting technical data and estimated costs. This material can be found in detail in the individual reports, but has been summarized and consolidated for reporting in thiis analysis.

In summary, major emphasis was placed upon the application of identical rules for the study contractors and the program in general in order to assure a common basis for comparison purposes.

A summary and a comparative tabulation of the cost estimates for the different systems is presented in appendix B. Each contractor has stated that their reported costs are consistent with the general practices used in their commercial estimating procedures.

In some instances, it has been found desirable to normalize certain reported costs to permit equitable evaluation of systems irrespective of the supplier. The action of the evaluation group in this regard has been limited to those items:

(1) where obviously an erroneous assumption has been made, or

(2) where variations in design optimism and/or design innovations (which could apply to more than one of the systems) suggest normalizing for comparison purposes, or

(3) where there is an irreconcilable difference between contractors' figures for similar services or equipment.

A summary including brief descriptions of the different systems and a comparative analysis of the technical aspects of the systems are included in this report as appendix C. An attempt has been made to limit evaluation group comments to those items:

(1) which are unique or which differ from one system to another, or

(2) which required comment to emphasize certain design features.

Considerable care was taken during the course of the studies to maintain consistency among the contractors with respect to the degree of optimism in design and of technological improvement incorporated in the reference reactor system designs. In spite of the care exercised, as might be expected, this was found to vary from contractor to contractor. An analysis of these variations is included in appendix C. The future potential of these systems is discussed in appendix D. The contractors' reports have been put in final form and are listed in appendix E.

Technical Summary

The development of light water cooled and moderated reactors, which originated with the pressurized water reactor design, has evolved along three major lines: improvement of the basic PWR design; the development of boiling water reactors retaining the indirect cycle nonradioactive secondary steam characteristics; and the development of direct cycle boiling water reactors. Each of these systems has taken advantage of using low enrichment fuels, increasing power density, decreasing fabrication costs, etc. While it is realized that the technical evolution of these systems is converging, the following discussion is primarily limited to design features not necessarily common to all three approaches in order to emphasize the tradeoffs associated in comparing them.

The major improvements made in the basic PWR design to date include the development of inherent load following capability, the elimination of multiple coolant loop systems when used in applications having less demanding reliability and damage backup requirements, the generation of secondary steam having a limited degree of superheat, the use of controlled leakage primary circulation pumps, and even limited hot channel bulk boiling. Future development potential includes the elimination of the pressurizer (self-pressurization) and elimination of the primary pumps (natural circulation).

The indirect cycle BWR was developed primarily to gain greater cooling capacity with less pumping power. Increasing the void content within the reactor core and the introduction of chimneys above the core have permitted the adoption of natural circulation, thereby removing the recirculation pumping functional requirement. In addition, the retention of the major portion of the radioactive primary coolant liquid within the reactor pressure vessel reduced the external shielding requirements. Retention of the primary heat exchangers retained the ability to generate nonradioactive steam for engine room use with a limited degree of superheat. The primary penalties paid for these advances were more rigid control system requirements since the presence of varying steam voids in the core tends to oppose the load following capability of the indirect cycle; coolant recirculation problems when natural circulation systems are subjected to ships motion; and the use of larger off-gas recombining and storage systems since the boiling phenomena increase the separation of radiolytically dissociated water molecules.

The direct cycle BWR permitted a further reduction of power generation costs through the elimination of systems components. It has done so primarily by removing the requirement for nonradioactive steam in the engine room, with the attendant removal of the main heat exchanger and the consolidation of the primary and secondary piping and auxiliary systems functions. Boiling within the reactor core has again allowed natural circulation designs to eliminate the requirement for recirculation pumps. The combination of these two changes has also allowed the use of less secondary shielding since nearly all of the radioactive primary coolant liquid is contained within the pressure vessel and primary shield. However, the reduction of secondary shielding has not shown as great an advantage in the tanker design, where bulk cargo is utilized as secondary shielding, as it would in other applications where fixed shielding is required. The ability to obtain reasonably high temperature conditions with lower reactor pressures than either of the indirect cycle concepts is particularly important from a neutron conservation point of view, since the fuel cladding, which absorbs neutrons, can be reduced in thickness.

The elimination of these functional requirements in the direct cycle BWR has not, however, been accomplished without incurring certain other penalties. The system is limited to saturated steam conditions (until superheat systems are developed) requiring that more expensive saturated turbines be used. In addition, the presence of radioactive steam in the engineroom has required that special shielding and seals be placed on the main propulsion machinery and auxiliaries, that this area be designated a limited access area, and that some remote control equipment and instrumentation be employed. This latter fact is, however, partially balanced by a minor reduction in the engineroom crew requirement. Additional functional requirements placed on the system include the use of a full flow condensate purification system to prevent sea water, which may leak in through the condensers, from reaching the reactor; more rigid control rod motion requirements since the system inherently tries to oppose load changes; and the use of a larger off-gas recombining and storage system since the separation of radiolytically disassociated water molecules is enhanced by boiling and the recombination and storage problem is enlarged by air in-leakage through the low pressure condensers. This latter penalty, while not severe, since disposal at sea was allowed for the design studies, might be enlarged if the vessel were designed for coastwise operation where disposal is more limited. The major unresolved question on the direct cycle BWR concerns the effects of ship's motion on the reactor system. Experimental and analytical studies have shown that this factor will probably not be a major problem. However, additional experience in this area will be required before a final determination can be made. In addition, further experience is needed to eliminate completely the problem associated with possible release of radioactive waste through the main condenser systems to the sea.

The major area of future potential improvement for the direct cycle BWR plant is the development of integral nuclear superheat with its attendant increase in overall thermal efficiency and propulsion machinery cost and weight reductions.

SUMMARY DESCRIPTIONS

PWR.—The PWR reference design incorporates single pass forced circulation of 2,000 p.s.i. light water as coolant and moderator with limited hot channel bulk boiling at a normal power rate of 75 MW(t). The reactor coolant outlet (620° F.) is pumped through a superheater to a steam generator and back to the reactor

by two controlled leakage pumps via a single primary piping loop containing no valves other than the check valves at the pumps. Secondary nonradioactive superheated steam at 600° F., 600 p.s.i., is generated to drive the propulsion turbine and auxiliaries at an overall thermal efficiency of 27.3 percent.

Indirect cycle BWR.—The indirect cycle BWR reference design uses single pass natural circulation of 2,000 pounds per square inch light water as coolant and moderator producing saturated steam (636° F.) at a normal power rate of 70 megawatts (thermal). The saturated steam is fed to a dual condenser-evaporator, superheater, and subcooler heat exchangers in a dual-loop system. Secondary nonradioactive superheated steam at 603° F., 690 pounds per square inch, is generated to drive the propulsion turbine and auxiliaries at an overall thermal efficiency of 29 percent.

Direct cycle BWR.—The direct cycle BWR reference design uses single pass natural circulation of 1,000 pounds per square inch light water as coolant and moderator producing saturated steam at a normal power rate of 72 megawatts (thermal), and an overall thermal efficiency of 28.5 percent including ship's auxiliary services. The saturated steam is fed directly to the propulsion turbine and main condenser via a single loop and then passed through full flow resin bed demineralizers prior to return to the reactor by the main feed pumps.

Comparative data

	Pressurized water reactor (PWR) tanker	Boiling water reactor (BWR)	
		Indirect tanker	Direct tanker
Length ..... feet	750	750	750
Beam ..... do	102	102	102
Cargo capacity ..... tons	42,776	42,918	43,125
Speed ..... knots	18.3	18.3	18.3
Maximum power to propeller ..... shaft horsepower	30,000	30,000	30,000
Reactor power (maximum) ..... megawatts (thermal)	82	77.4	78.5
Overall thermal efficiency ..... percent	27.3	29.0	28.5
Fuel	UO_2	UO_2	UO_2
Cladding	[1]	[1]	[1]
Number of zones	[2]	[2]	[2]
Refueling period ..... years	2.34	2	0.867
Enrichment ..... percent	4.35–6.16	3.21	3.11
Average fuel exposure ..... MWD/metric ton	13,000	11,820	13,200
Reactor outlet temperature ..... degrees Fahrenheit	620	636	546
Reactor pressure ..... pounds per square inch absolute	2,000	2,000	1,015
Steam temperature ..... degrees Fahrenheit	600	603	546
Steam press ..... pounds per square inch gage	600	690	980

[1] Stainless steel.
[2] Fixed.
[3] Shuffled.

Conclusions

1. The detailed parameters used in this evaluation as design study assumptions and the enforcement of these rules have resulted in the design of three nuclear propelled ships and one conventionally propelled ship which can be compared on a realistic basis.

2. The 40-month schedule used in the design assumptions is sufficient for developing, designing, and building a nuclear tanker using either the direct cycle BWR or the PWR reference designs, including the necessary R. & D. However, this schedule does not contain any provision for program approval or contingency for upgrading the reference design. If a definite decision is made to proceed with a project, the detailed factors affecting scheduling will need careful scrutiny before the program schedule is fixed.

3. A development and construction program using the indirect cycle BWR reference design could not be carried out on a 40-month schedule pending further development work in high pressure BWR technology.

4. Each of the three systems studied could in all probability be used to provide a reliable and safe proplusion plant. Thus the selection of a prototype propulsion plant for early application to a tanker resolves itself into selecting a plant (1) with the greatest economic potential; (2) with broadest application to the merchant marine; and (3) which would provide the greatest amount of new operating information.

5. The economic analysis was made on a dual basis in order to show both the normal broad application on relatively short U.S. coastwise trade routes using current depressed market construction costs for the conventional tanker, and the more limited application in longer trade routes where economic competitiveness would be more easily attained. This method of analysis is quite analogous to the central station powerplant dual analysis where it is expected that large powerplants operating on baseload conditions in high fuel cost areas will become competitive before small powerplants operating in lower fuel cost areas. Table A summarizes the relative cost data of each of the three reference nuclear tankers and a comparable conventional fossil fuel powered tanker on the broad application gulf coast to east coast trade route. Table B summarizes the relative cost data for the same tankers on the more limited Persian Gulf to east coast trade route. Table B also includes the cost information submitted by design study contractors. These values are based upon only the long route assumption and include a comparison with a conventional ship whose cost is based upon the Martime Administration's estimate of long-range construction costs instead of the current depressed market value. Both table A and table B display annual operating costs with and without amortizing first-of-a-kind (noncapitalized) costs. The conclusions which may be drawn from these tables include—

(*a*) The delivery cost per ton on short U.S. coastwise routes is 22 percent to 50 percent more for the nuclear powerplants depending upon the powerplant chosen.

(*b*) Although nuclear power is more expensive than conventional power, it is approaching a position of economic competitiveness for large fast ships operating on long trade routes.

(*c*) As can be seen from table B, capital costs of the water reactor propelled ships studied are approximately 29 to 70 percent more than the similar conventional powered ship under long-range construction cost conditions.

(*d*) The total annual operating costs for the longer trade route application, exclusive of fuel, are 25 to 54 percent greater for these nuclear ships than for the comaparble conventional ship. However, due to the lower nuclear fuel cost and the capability of carrying more cargo, the cost per ton of cargo carried on the selected trade routes is only 3 to 24 percent greater for the nuclear ships.

(*e*) The BWR (direct cycle) has the lowest capital cost. However, the capital cost of the simplified single loop PWR is only slightly greater. The dual loops and multiple heat exchangers of the BWR (indierct system) result in an excellent plant efficiency (29 percent), but add greatly to the capital costs.

(*f*) There is significant difference in fuel costs, even after normalizing, with the BWR systems significantly lower than the PWR. This is due primarily to the thicker fuel cladding required by the high-pressure system, the higher neutron leakage from the smaller PWR core, and the lower overall thermal efficiency.

(*g*) The cost of the research and development program required for the direct cycle BWR and the PWR reference designs would be significantly less than for the indirect cycle BWR reference design. In addition, a greater degree of confidence is held in the direct cycle BWR values since the program for this system is more confirmatory in nature than the programs for either of the other two reference designs. However, the values shown represent primarily the necessary effort to convert land base designs to maritime applications and are highly dependent upon the continuance and successful completion of certain central power station research and develop-

ment programs now in progress. A more detailed discussion on this point is presented in appendix C.

6. Reduction of the direct cycle BWR fuel fabrication costs beyond the values quoted in the reference designs should be possible. A cost decrease of from $86 to $70/KgU and extension of the average fuel exposure from 13,200 to 16,500 MWT/MT would reduce the annual operating costs to the point where the nuclear-powered ship might become competitive with the conventional ship in the longer trade route application. Both of these reductions appear to be achieveable in the second or third cores for the reference direct cycle BWR design.

7. Additional fuel costs savings should ultimately be possible through further reductions in cladding thickness, and extending average exposures to 19,000 MWD/MT. Longer range future potential cost reductions for the direct cycle BWR lie chiefly in the development of integral nuclear superheat with its attendant increase in thermal efficiency and decrease in propulsion machinery cost and weight. The BWR system is also amenable to further automation with the possibility of reducing the crew requirements.

8. Potential fuel cost reductions, for the indirect cycle BWR and PWR reference designs, do not appear to approach a competitive position with conventional plants in the as-built reference application. In addition, the future potential of these plants by the use of nuclear superheat or further component reduction do not appear to be as attractive as the potential to be gained from developing an integral nuclear superheat-direct cycle BWR system.

9. The direct cycle BWR, because of its lower capital and operating costs, and because of its greater future potential, will be the most likely system to achieve competitive power in the near future. The PWR would be the second choice because of its reasonable capital costs and its very desirable, simple operating characteristics. The BWR indirect cycle, while having some desirable features, would be the third choice.

10. The choice of the direct cycle BWR power plant for a tanker application is further supported in that this concept would also likely show a fuel and capital cost advantage in larger and/or multiple plants for other maritime applications.

11. The numbers reported in this study reflect the costs that would be incurred by building the ships in U.S. shipyards, operating them with U.S. crewmen, at a design speed of 18.3 knots, and routing the loaded ship around the Cape of Good Hope. The world market cost of transporting oil is significantly lower due to many reasons, including the reduced capital costs of ships constructed in foreign yards, which are about 50 percent of U.S. cost, lower foreign crew costs which are approximately 35 percent of U.S. crew costs, lower design speeds, and operation through the Suez Canal both ways with somewhat smaller or incompletely loaded vessels. In actual practice, larger vessels in all probability would be operated on the cape run. A direct comparison of the world market cost to the cost of transporting oil by the nuclear-powered tankers must not be made, since nuclear ships built and operated under foreign standards would also be significantly lower.

TABLE A.—*U.S. coastwise cost summary (gulf coast to north of Hatteras—1,930 miles one way)*

	Direct cycle boiling water		Indirect cycle boiling water		Pressurized water		Conventional
	First of a kind	Second of a kind	First of a kind	Second of a kind	First of a kind	Second of a kind	
I. CAPITAL COST							
A. Nuclear steam supply system	$4,917,000	$4,917,000	$7,017,000	$7,017,000	$5,777,000	$5,777,000	$671,800
B. Main propulsion and auxiliary machinery systems	5,191,000	5,191,000	5,054,000	5,054,000	5,267,000	5,267,000	4,161,600
C. Hull and outfit	10,671,000	10,671,000	10,606,000	10,606,000	10,604,000	10,604,000	9,164,800
D. Cost of construction funds (6 percent per year)	1,558,000	1,558,000	1,700,000	1,700,000	1,617,000	1,617,000	1,049,800
Total capital costs	22,337,000	22,337,000	24,377,000	24,377,000	23,265,000	23,265,000	15,048,000
II. FIRST-OF-A-KIND COSTS							
A. Research and development	2,075,000	----------	2,150,000	----------	2,000,000	----------	----------
B. Engineering	1,652,000	----------	2,260,000	----------	1,930,000	----------	----------
C. Fuel costs in excess of equilibrium	270,000	----------	369,000	----------	----------	----------	----------
D. Crew training	200,000	----------	200,000	----------	200,000	----------	----------
E. Refueling equipment costs	110,000	----------	101,000	----------	74,000	----------	----------
Total first-of-a-kind costs	4,307,000	----------	5,080,000	----------	4,204,000	----------	----------
III. ANNUAL OPERATING COSTS							
A. Fixed charges (salaries, maintenance, etc.)	733,000	733,000	747,000	747,000	754,000	754,000	692,000
B. Port and canal fees, overhead, and miscellaneous	125,000	125,000	125,000	125,000	125,000	125,000	125,000
C. Interest, depreciation, and insurance (nuclear 10 percent, conventional 9½ percent)	2,664,000	2,234,000	2,946,000	2,438,000	2,746,000	2,326,000	1,430,000
D. Fuel costs	585,000	585,000	620,000	620,000	786,000	786,000	801,000
Total annual operating cost	4,107,000	3,677,000	4,438,000	3,930,000	4,411,000	3,991,000	3,048,000
IV							
Fuel cost, mils/shp–hr	3.03	3.03	3.14	3.14	3.93	3.93	3.92
Cargo capacity/year (long tons)	1,399,300	1,399,300	1,392,600	1,392,600	1,388,000	1,388,000	1,421,000
Delivery cost/ton (dollars)	2.94	2.62	3.19	2.82	3.18	2.88	2.14

Mr. Godwin, who is chief of the Maritime Reactors Branch of the Commission's Reactor Development Division, is prepared now to go ahead with a presentation of the three studies.

Representative HOLIFIELD. Mr. Godwin.

Mr. GODWIN. Mr. Chairman, over the last 8 months, as Mr. Luedecke said, we have studied three reactor systems. All of these reactor systems were selected on a common basis. That is, that the systems that were reviewed were relatively far advanced as far as technology was concerned. They were all water systems. The common basis, as far as the ship type was concerned, was determined by the Maritime Administration. The reference ship was a 43,000-ton deadweight tanker of 30,000 shaft horsepower. All of the studies employed the same ship and the same common reference trade route or routes.

We selected one long trade route, the Persian Gulf run to the east coast of the United States, which is a very long run of about 17,000 to 20,000 miles, and a shorter run which was more characteristic of the American merchant marine, that is, from the Gulf of Mexico to the east coast of the United States.

I should point out and emphasize at the outset that the studies which were carried out were to arrive at comparative cost and economics and the technical possibilities of the various systems. We did not attempt in these studies to arrive at the optimum ship type or tanker type, but rather to find out with these studies which reactor type looked like it had the greatest potential for the maritime service.

The selection of a tanker was determined at the outset as not necessarily being representative of all the trade routes or ships, but was a good reference vessel at this time.

Representative HOLIFIELD. Was this because you have more oil cargoes than you do ore, or other commodities?

Mr. GODWIN. I think the selection of a tanker was most appropriate, primarily because a tanker normally operates at full capacity. It is usually fully loaded. It usually operates on long runs. At the time the work on the tanker began this ship type looked like it would achieve economic parity with conventionally powered tankers the soonest. We think this is probably still true, although if a ship were built and if it were determined that we wanted to get as close to economic operation as possible, we would have probably recommended the construction of a larger ship.

Representative HOSMER. What tonnage did you say?

Mr. GODWIN. Nominally 43,000 deadweight tons.

(Chart of weight summary follows:)

Weight summary

	Tons
Light ship:	
Hull and steel	10,416
Outfit	1,742
Machinery [1]	2,811
Margin	401
Total	15,370
Crew, stores, water and fuel oil	750
Cargo oil	43,125
Displacement	59,245

[1] Includes reactor, shielding, and containment.

Representative VAN ZANDT. What route did you use to the Persian Gulf?

Mr. GODWIN. Fully loaded around the cape and back through the canal. We actually looked at it from four different alternatives: Both ways through the canal; part of the reason for selecting the 43,000-deadweight-ton tanker as the reference vessel was: (1) Because this ship was relatively flexible, and it could operate through the canals both ways fully loaded, Panama and Suez. (2) It could also be used as a fleet support vessel for the Navy in emergencies. (3) The reference ship did have the capacity to operate relatively easily in the domestic trade, this is the gulf to the east coast, and not be so small that it could not be used on the longer runs, such as the Persian Gulf. It was not optimized but it was a good study vessel.

Representative VAN ZANDT. Could you give us percentagewise the time the ship would spend at sea?

Mr. GODWIN. 85 to 86 percent of the time. This is another factor why the tanker would be looked at earlier.

Representative VAN ZANDT. Based on your present thinking, what would be your top and cruising speed?

Mr. GODWIN. In the reference vessel we selected a powerplant of 30,000 shaft horsepower. The reason we selected this power was for several reasons, but principally it was the largest amount of power we could put on a single shaft ship. This gave us in a 43,000-ton tanker a speed of about 18.5 knots.

Representative VAN ZANDT. That is the top speed?

Mr. GODWIN. This would be the top speed of that particular vessel. Adding more power we could have increased it. As a matter of fact, the nuclear ship would probably operate at something higher in terms of the most economic speed than would the conventionally powered ship.

In these studies we did not attempt in any way to build increased automation into this system. The nuclear system does lend itself to automation and simplification. We did not attempt to modify the design features of tankers as presently built.

Representative HOLIFIELD. You did not consider the underwater proposition that the Japanese were interested in?

Mr. GODWIN. No, we did not in these reference studies. We felt this is certainly an attractive future possibility but for comparative purposes to arrive at the optimum plant we did not.

Representative HOSMER. Why, may I ask, did you leave out the automation features?

Mr. GODWIN. One of the ground rules of these studies was that we would like to have the ship in service in about 4 years. This was to rule out a high degree of optimism as to what might be over the hill but which we just don't know anything about at the present time. This is one of the features which we would say is certainly coming. The benefit of nuclear power to the merchant marine stems in a major way from the amount of automation, and the ability to get the crews above deck. In other words, operate ships from the bridge. This includes the machinery as well as the navigational aspects.

As I say, the reason we did not was to avoid trying to build in too many things which we could not do now and keep to reality as closely as possible.

Representative VAN ZANDT. In comparing the space factor between a nuclear and conventional powerhouse, can you give us any information on it?

Mr. GODWIN. As far as cargo capacity of a tanker is concerned—and you will notice in the handout you have that there is a higher cargo capacity in a nuclear vessel than in a comparable conventionally powered ship. The best rule of thumb is that for a given horsepower, a normal ship would burn about one-half pound of fuel per shaft horsepower per hour. This would increase the cargo capacity of a ship by about that much. So on a long run, say the Persian Gulf run, one could increase the cargo capacity by a factor which would be directly related to the horsepower of the vessel; on the Persian Gulf run two to three thousand tons per trip. We will elaborate on this in the economics later.

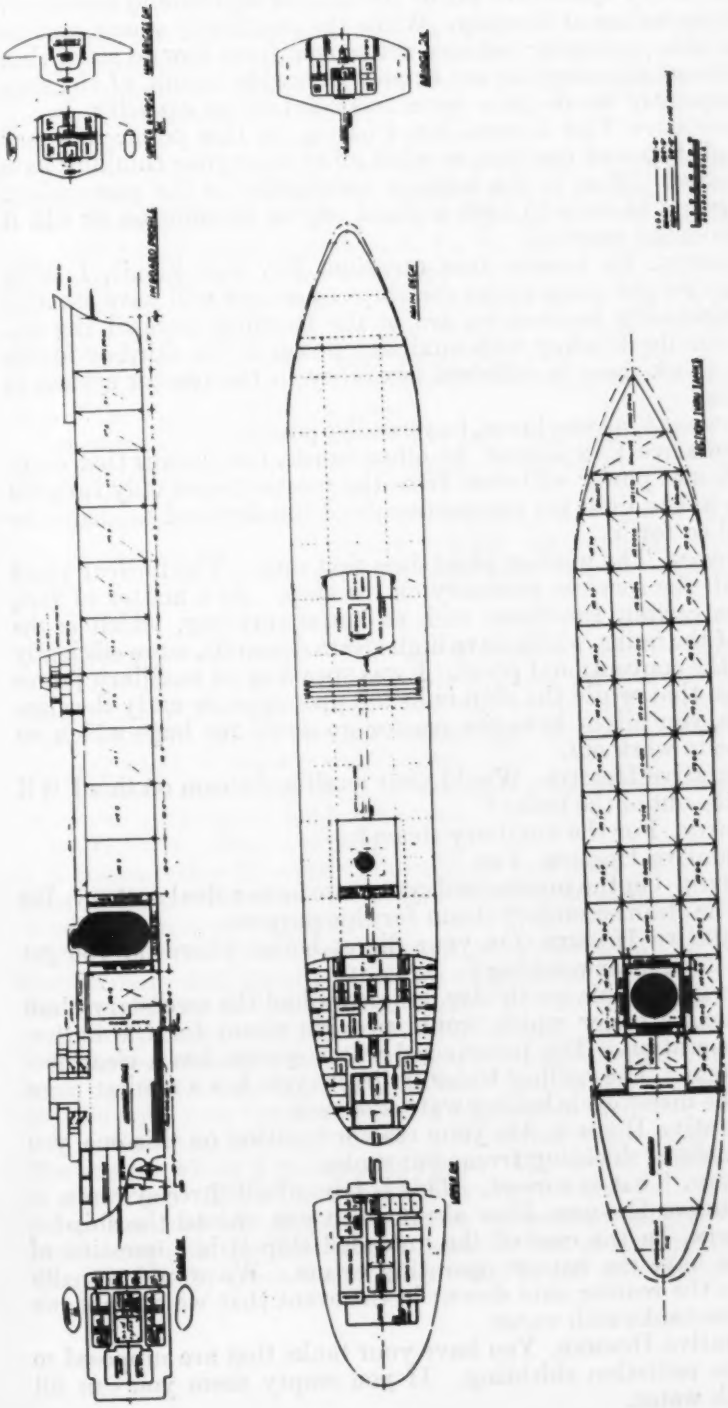
The objective of these studies, as I say, was principally to get a common basis and not to optimize for a ship construction program now. We wanted to identify a prototype reactor which could be built in the next 4 years, that would have relatively broad application to the merchant marine, and not limited to tankers. Also, the plant had to be amenable to improvements in efficiency and simplification. The most significant factor which I think emerges from these studies is that there is no clear reason why the costs of nuclear power in a ship need be any higher than for a land based nuclear powerplant of the same size. There is no obvious reason why it should not be. Thus, the power cost should be about the same.

We trade off conventional plant structural facilities as against the increased structural requirements of a nuclear vessel. So it comes out very much the same in terms of mills per shaft horsepower.

In these studies, as I mentioned, the three systems which were studied, which we believe are best known, are the pressurized water reactor, the indirect boiling water reactor concept and the direct boiling water reactor concept. Each of these systems was looked at in a variety of ways and optimized for the maritime application.

What I would like to do this morning is briefly run through the technical differences between these three systems, give you some advantages and disadvantages of each of the systems and present the conclusions that we have reached in terms of the economic performance of these reactors in this ship.

The first plant which I would like to discuss would be the pressurized water reactor. This particular system is 30,000 shaft horsepower, and the reference vessel, as you will see here, in the first slide, is shown principally to demonstrate the relative size of the powerplant. The reactor you can see is in the dark outline. The weight of this particular system is about 2,800 tons. This compares to the *Savannah* plant of, roughly, 3,800 tons. This plant on the other hand is 30,000 shaft horsepower as contrasted to the *Savannah's* 20,000 shaft horsepower.



The machinery spaces are aft of the reactor and extend essentially along the centerline of the ship. While the machinery spaces and the reactor in this particular instance are longer from bow to stern than a conventional ship they do not extend from side to side of the ship, and consequently we do gain some increased cargo capacity.

Representative VAN ZANDT. Mr. Godwin, at this point, this may apply to all types of reactors, so what effect does your thinking have on auxilaries? That is the support auxiliaries to the powerplant. Are you going to have to have a diesel engine in addition or will it all stem from the reactor?

Mr. GODWIN. To answer that question, Mr. Van Zandt, I think initially as we put these prototype ships to sea we will have standby power, principally because we are in the learning state of the art. We can actually do away with auxiliary power in the third or fourth vessel. I think there is sufficient flexibility in the reactor system to permit this.

The *Savannah*, as you know, has standby power.

Representative VAN ZANDT. In other words, that means that eventually sufficient power will stem from the reactor to not only turn the propellers but to light the compartments of the ship and condense the water, and so forth.

Mr. GODWIN. The nuclear plant does that now. The nuclear plant provides all the services necessary on the ship. As a matter of fact, it provides certain functions, such as butterworthing, which is the cleaning of the tanks, which have high steam demands, more efficiently than does the conventional plant. I was speaking of auxiliary power in the sense that while the ship is in the prototype or early development stage, you might have the reactor go down for bugs which we would hope to work out.

Representative HOSMER. Would your auxiliary steam on this PWR type be taken out of the boiler?

Mr. GODWIN. For the auxiliary steam?

Representative HOSMER. Yes.

Mr. GODWIN. On the pressurized system we have a dual system. We would use the clean secondary steam for this purpose.

Representative HOSMER. On your direct boiler where do you get your steam for butterworthing?

Mr. GODWIN. In this particular design we had the secondary clean steam condenser boiler which would provide steam for the butterworthing operation. The pressurized water system has a clean secondary system. The boiling water indirect cycle has a similar clean system. The direct cycle boiling water does not.

Representative HOSMER. On your reactor location on this one, you have the benefit of shielding from your tanks.

Mr. GODWIN. That is correct. This is true of all three systems.

Representative HOSMER. How about when you unload the ship?

Mr. GODWIN. In the case of the unloaded ship it is a question of whether you have the reactor operating or not. We would actually plan to have the reactor shut down; in the event that we did not, we could fill those tanks with water.

Representative HOSMER. You have your tanks that are supposed to provide some radiation shielding. If you empty them you can fill them up with water.

Mr. GODWIN. That is correct.

Representative HOSMER. Then you have a problem of getting water in there before you butterworth. You have problems with port regulations on tankers which are very strict in this regard, and so forth. Are those all factored into this?

Mr. GODWIN. Yes; these are all factored.

Representative HOSMER. How do you factor this problem of local port regulations regarding the loading and unloading of tanks?

Mr. GODWIN. First of all, you have to analyze whether or not the ship itself loads fuel on both ends for its own purposes. We would carry oil for certain other auxiliary services in this particular ship which we are talking about. So we would never have a completely unloaded ship in terms of fuel for auxiliary boilers and this kind of thing. We would always have some fuel aboard. But in the event that we did take it all off, we could fill the tanks with water and dispose of the water at dockside later.

Representative HOSMER. You have less than 5 percent of your fuel-carrying capacity, port and starboard, doubling up as shielding.

Mr. GODWIN. That is correct.

Representative HOSMER. You have to do something with that when you unload the tanks. You say you are not running from beam to beam with your powerplant and, therefore, you are picking up some extra space.

Mr. GODWIN. That is correct.

Representative HOSMER. How are you going to handle that problem?

Mr. GODWIN. First of all, it is not a major problem as far as these water systems are concerned. You can appreciate when the reactor is shut down we can go into the containment areas. The levels rapidly decrease when the reactor is shut down.

Representative HOSMER. You are going to have to light off the reactor to get from dockside out to sea.

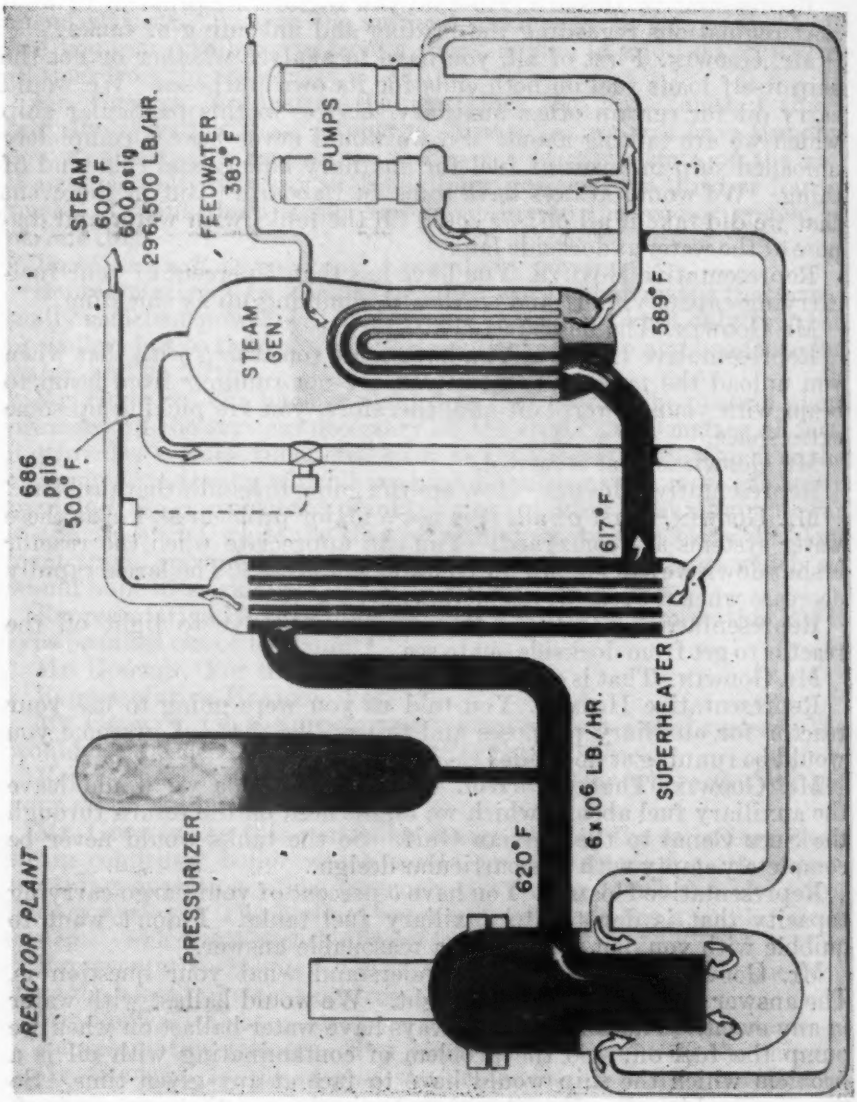
Mr. GODWIN. That is correct.

Representative HOSMER. You told us you were going to use your reactor for auxiliary purposes and things like that. I presume you would be running at dockside?

Mr. GODWIN. That is correct. Also, at dockside we would leave the auxiliary fuel aboard which we might need on the return through the Suez Canal to the Persian Gulf. So the tanks would never be completely empty with this particular design.

Representative HOSMER. You have 5 percent of your cargo-carrying capacity that is devoted to auxiliary fuel tanks. I don't want to quibble with you, but that is not a reasonable answer.

Mr. GODWIN. Maybe I don't understand what your question is. The answer which I gave you is right. We would ballast with water in any event. The ship would always have water ballast on when we pump the fuel off. So the problem of contaminating with oil is a problem which the ship would have to face at any given time. So then we would replace the oil with water in the case that you speak of.


REACTOR PLANT
PRESSURIZER
620°F
6x10⁶ LB./HR.
SUPERHEATER
617°F
589°F
686 psia
500°F
STEAM GEN.
PUMPS
FEEDWATER 383°F
STEAM 600°F 600 psig 296,500 LB/HR.

Representative HOSMER. Go ahead.

Mr. GODWIN. The next slide. This is the pressurized water system. If this particular slide is not clear, a similar picture is shown in the handout. You will notice the reactor located on the left is essentially the pressurized water reactor as we know it. The major difference between this particular system and the others is that it is a single loop system. It does not have a dual loop as in the *Savannah* or multiple loops as in most naval plants. The hot water is generated in the reactor on the left. It goes through the superheater and into the steam generator on the right, then returns to the reactor after being pumped by two primary circulation pumps back to the reactor. This particular system, as you note, produces superheated steam and has an efficiency of about 27 to 28 percent, which is relatively good for this application.

The reactor is controlled by 21 control rods of silver-indium-cadmium. The fuel is shown in the lower section of the reactor and is uranium oxide encased in stainless steel.

Another difference between this PWR reactor and others is the fact that it does produce superheated steam and is relatively small as contrasted to the boiling water reactors. The power density of this reactor is about 60 kilowatts per liter.

Mr. TOLL. Mr. Godwin, what is the heat source for your superheater? Do you have to have a coal fire?

Mr. GODWIN. No. This is a nuclear superheater. The reactor is at 2,000 p.s.i., produces steam which in this dual heat exchange arrangement produces superheated steam to the turbines.

Mr. TOLL. Where are the superheaters?

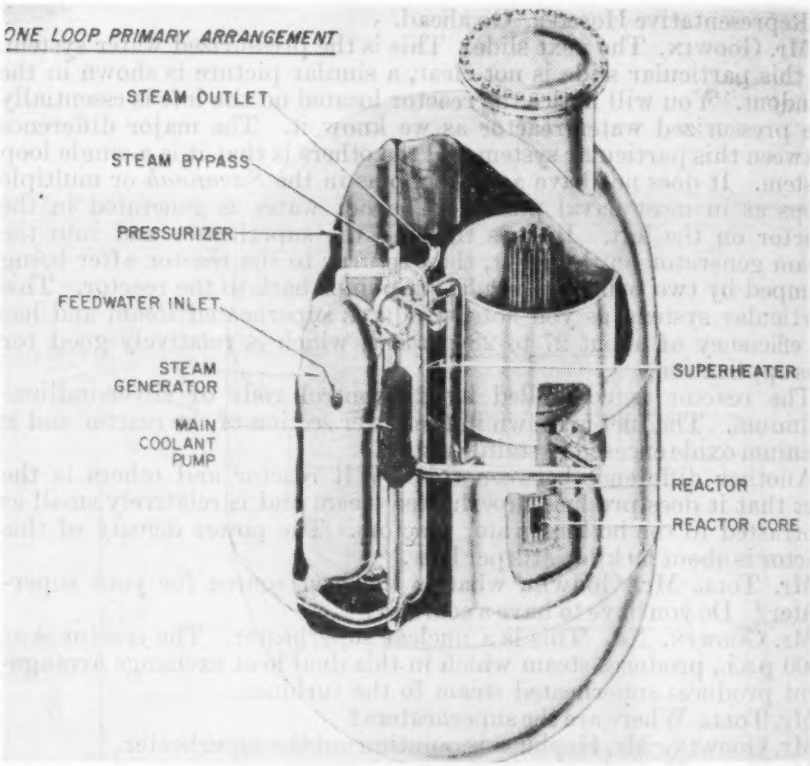
Mr. GODWIN. Mr. Hepburn is pointing out the superheater.

Mr. TOLL. How about on the next slide?

Mr. GODWIN. It is not in there. The next slide coming up will show the location of the superheater. Are you asking the question, do you put the steam back in the reactor? The answer is "No" to that. It is not integral nuclear superheat if that is the question.

Representative VAN ZANDT. Who is doing the design study?

Mr. GODWIN. The PWR design study is being done by Combustion Engineering. The reactor is at 2,000 p.s.i. It is relatively high pressure.



In the next slide, I think you will get the answer to your particular question. The superheater, as you can see there, is marked. It is in the center of the containment vessel. The steam generator is on the left with the reactor on the right. You will notice on the top of the reactor a large cylindrical vessel. This is included principally to assist in changing fuel. It is an integral part of the ship's structure to facilitate refueling, which we would do on about a 2-year cycle. We would remove the head and all the fuel at one time. We would fill the cylindrical vessel with water and work down through the water to remove the fuel.

Representative VAN ZANDT. What is your thinking at the present time as far as changing the cores?

Mr. GODWIN. In these studies we looked at three arrangements. In this particular system we change all the fuel on a 2-year cycle. The boiling water indirect cycle changes fuel every 2 years, but in that case we only remove half the fuel and shuffle the remaining fuel elements.

On the direct cycle boiling water reactor, about nine-tenths of a year or each 10 months of operation, we would remove one-third of the core and shuffle the other two-thirds, replace one-third.

Representative VAN ZANDT. From the standpoint of the ship's hull, what is necessary in changing the core?

Mr. GODWIN. As far as the ships hull is concerned, there is no particular arrangement necessary.

Representative VAN ZANDT. It will be handled through the deck?

Mr. GODWIN. Yes. The deck hatch is open and exposes the containment vessel which you see there. This is an envelope which surrounds the primary system. It is designed to withstand 150 p.s.i., which assumes the complete and instantaneous release of all the primary water. When the reactor operates it would be closed and sealed at all times.

Representative HOLIFIELD. The superheat is heated by fission?

Mr. GODWIN. The reactor heats the primary water, which runs through the superheater, which transfers its heat to lower pressure steam, you might say, which brings it up to a superheated condition. In other words, at high pressures and temperatures we can bring the primary water to a point where it would give some superheat, a very small amount of superheat, to the secondary steam, in a separate heat exchanger.

The principal advantages of this particular system are the fact that there is a great deal of information available on the pressurized water system. There is also the benefit that there is a strong inherent load following characteristic to the pressurized water system where demands of maneuverability are quickly met by the reactor system. The system is a lot less sluggish than other systems The boiling water reactor is more sluggish to change in power than the pressurized water reactor. The other advantages which I mentioned for the pressurized water reactor involve the availability of some superheated steam which reduces the size of the propulsion equipment considerably, and also has a beneficial effect on its efficiency. In the future we hope to do away with the pressurizer and have a self-pressurizing system.

Also, we would hope to lean in the future on a greater degree of natural circulation in the pressurized water system. This work, as you may know, is presently going on in the Navy program.

There are some disadvantages to the pressurized water system, however, and that is that the fuel costs are higher, as we will show you later in the economic comparisons. The pumps which are required in this particular system do add to the cost and also decrease the efficiency somewhat. This is a buffer sealed system which adds to the complexity in terms of handling the control leakage into the containment vessel. However, the system itself appears to be perfectly suitable for maritime purposes.

The next system which I would like to briefly describe is the indirect boiling water reactor.

The next slide, please.

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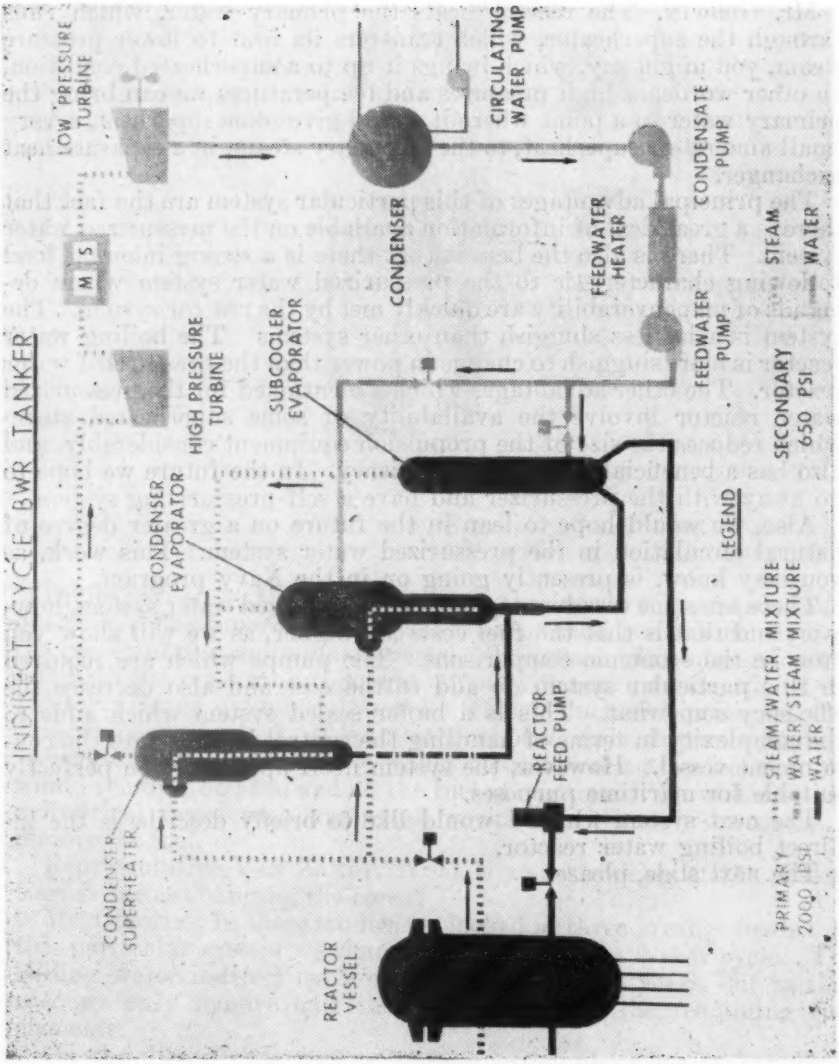
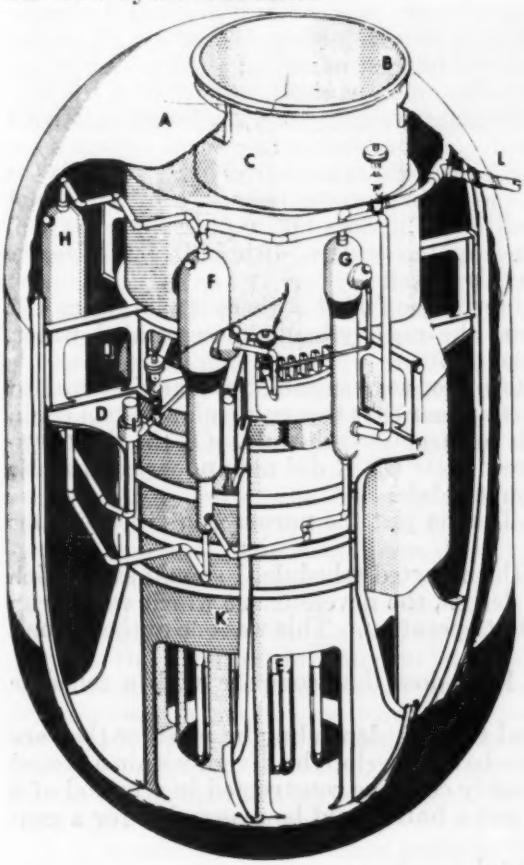

INDIRECT CYCLE BWR TANKER
LOW PRESSURE TURBINE
M S
HIGH PRESSURE TURBINE
SUBCOOLER EVAPORATOR
CONDENSER
CIRCULATING WATER PUMP
CONDENSATE PUMP
FEEDWATER HEATER
FEEDWATER PUMP
CONDENSER EVAPORATOR
CONDENSER SUPERHEATER
REACTOR FEED PUMP
REACTOR VESSEL
LEGEND
STEAM
WATER
SECONDARY 650 PSI
SLEAM/WATER MIXTURE
WATER/STEAM MIXTURE
WATER
PRIMARY 2000 PSI

In this particular system, the reactor on the left operating at about 2,000 p.s.i. produces steam which flows into the condenser superheater at the top. It then flows into the condenser evaporator which is in the center. These heat exchangers heat the secondary steam to a low order of superheat also. This is not in the pressure vessel or in the reactor, but develops from the three heat exchange stages and yields an efficiency which is quite good for this system of about 29 percent.

The secondary system in this boiling water system is shown in blue. The superheated steam leaves the condenser superheater at the top, flows into the high pressure turbine through a moisture separator, into the low pressure turbine which drives the ship's propellers, and back through the condenser and pumps into the heating cycle once again.

The principal difference between this and the other boiling water systems which we have looked at is that it does not have a fossil fuel superheater to get superheated steam. It operates at a higher pressure of about 2,000 p.s.i., and it has a higher degree of efficiency than the other systems studied.



A. VAPOR CONTAINER

B. HATCH

C. UNLOADING TANK

D. SUPPORT STRUCTURE

E. CONTROL ROD DRIVE MECHANISMS

F. CONDENSER - EVAPORATOR

G. CONDENSER - SUPERHEATER

H. SUBCOOLER - EVAPORATOR

I. REACTOR FEED PUMP

J. MAIN VALVES

K. PRIMARY SHIELD TANK

L. MAIN STEAM LINE

REACTOR PLANT ARRANGEMENT

The next slide. This is again the indirect boiling water cycle. This is similar to the previous slide on the pressurized water system. At the top you will notice the refueling cone which we would fill with water. In this case we would remove only part of the core at a given time, one-half of the core, on a 2-year cycle.

Its major features are the fact that this system has the control rod drives in the bottom utilizing the magnetic jack principle. This greatly simplifies the system to the extent that when we remove the fuel we do not have to remove the control rod drives. These can stay in place. The operation is greatly simplified by working through the top without interference from the control rod drives.

The other features of the system are the condenser superheater, which is G on that slide, the subcooler evaporator, which is H, and the reactor feed pumps, which are not too important, but are located around the periphery of the reactor.

I would like to point out some of the primary advantages of the indirect boiling water system.

First of all, since it is an indirect cycle it has clean steam in the engine spaces. We do not have any radioactive water that has been through the reactor in the machinery spaces. It has natural circulation which reduces the pumping requirements. It has a high degree of efficiency, as I mentioned, the highest of any of the systems which were carried out in these studies of 29 percent. Of course, the fact that it has superheat reduces plant weight. It does, however, have a disadvantage in that it requires a more stringent control system since the BWR has a more sluggish response to maneuvering. There is the effect of ship's motion on the boiling water reactor, which has not been completely resolved, although it does not appear that this will impose a serious problem on seagoing vessels. I should emphasize, we have not completed work on this aspect.

There is a third disadvantage in the fact that there is a large amount of off-gasses developed from the radiolytically disassociated water, which passes through the reactor.

This system again was determined to be suitable for maritime reactor purposes, although it did not appear that this particular system could be developed on a 40-month construction schedule. Of the three systems studied, only the indirect cycle BWR did not appear compatible with a 40-month construction schedule.

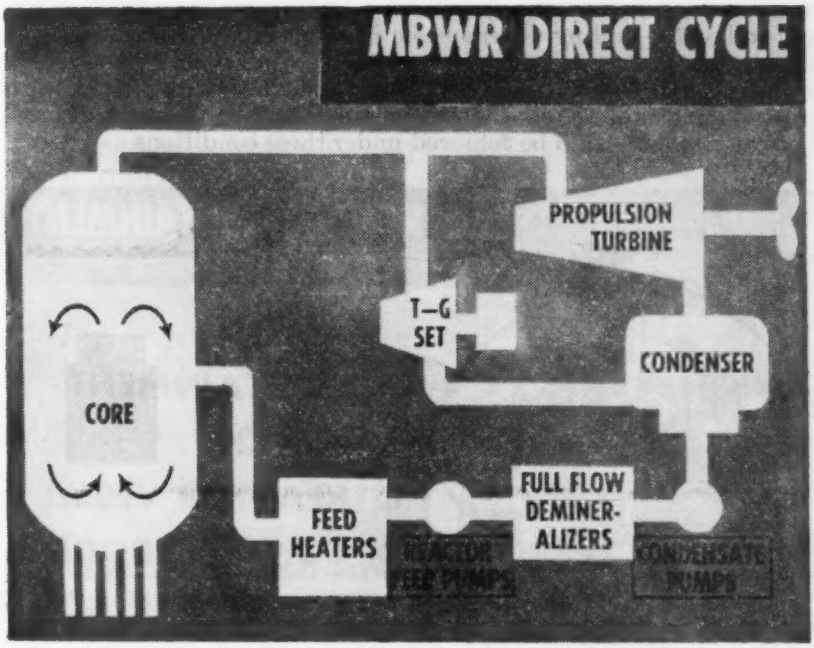
Representative HOSMER. That is just the normal construction time for the ship.

Mr. GODWIN. Forty-month projected schedule, I should say, which would include the detailed design, the development which would run parallel with it, and initial test operation. This was one of the ground rules of the study.

Representative HOSMER. How does that compare with a schedule for a conventional tanker?

Mr. GODWIN. Conventional tankers, depending on whether they are the first of kind, you could probably develop the design within a period of maybe 6 months. It probably could be constructed in a period of 8 months. A year or a year and a half would be reasonable for a conventional tanker.

Dr. WILSON. That is the total.



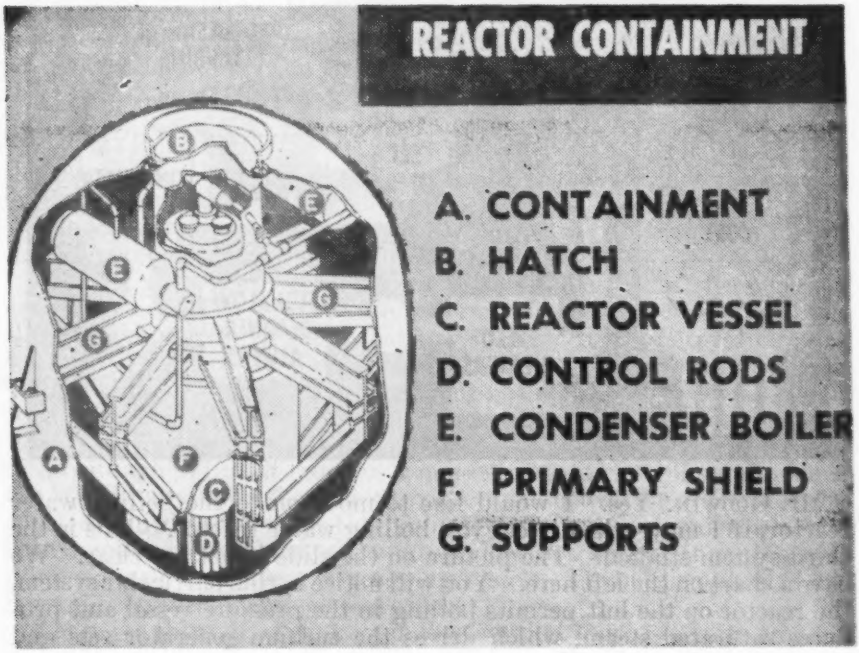
Mr. GODWIN. Yes. I would like to move on to the boiling water reactor, if I may—the direct cycle boiling water reactor. This is the third system studied. The picture on the slide is not too clear. We have a chart on the left here. You will notice in this particular system, the reactor on the left permits boiling in the pressure vessel and produces saturated steam, which drives the turbine generator sets and also drives the propulsion machinery. It returns through the condenser and full flow demineralizer back through the feed heaters and into the reactor. This is 1,000 p.s.i. pressure system. It produces saturated steam as contrasted to superheat in both other cases. It has an efficiency of 28 percent. It falls in the middle in terms of the efficiency range.

The advantages of the direct cycle boiling water reactor are that it is a very simple system. The direct cycle BWR, as you can see, has few systems. The steam flows directly into the turbines from the reactor without intermediate heat exchanges. The fact that the greatest percentage of the water inventory is in the pressure vessel reduces the amount of secondary shielding that is necessary. This system also has the potential for integral superheat in the future.

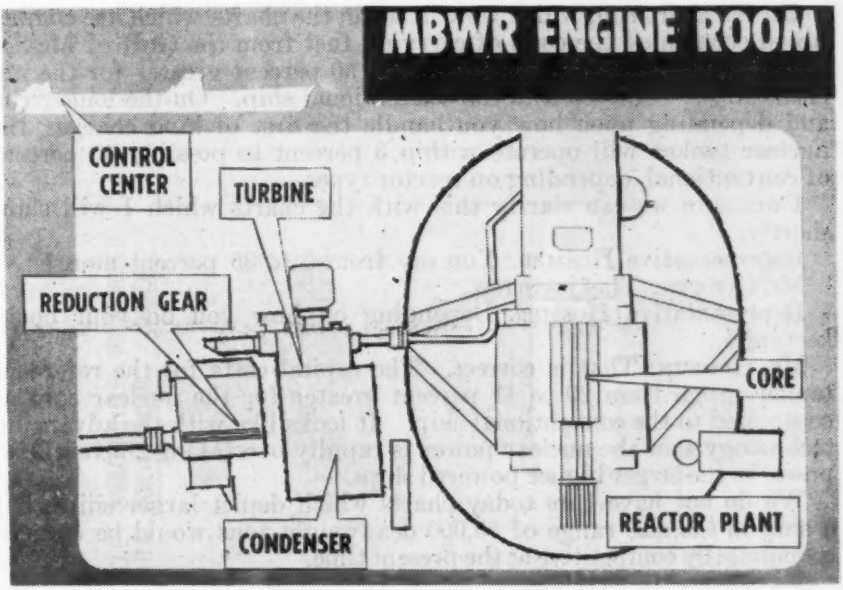
Its disadvantages stem mainly from the fact that we have radioactive steam in the turbine which does not give us the access to this equipment which would normally be the case on a conventional ship. The engine spaces, therefore, would be a limited access area, which would cut down their accessibility as far as a ship which could be built right now is concerned.

It also suffers from the same problem that the indirect BWR cycle does, that is, the effect of pitch and roll on the free surface of the

water in the pressure vessel. Work to determine the effects of pitch and roll on the boiling water system is going forward and at the present time it appears that under the worst conditions of the sea you might not be able to operate at full power, although there is probably not much question at the present time that some percent of power, 75 to 85 percent, could be achieved under these conditions.



We have one more slide which shows the arrangement of the boiling water reactor. In this particular case the containment vessel and the reactor arrangement is similar to the other systems. The reactor is controlled by 19 control rods from the bottom of the locking piston, hydraulic jack type. The fuel is uranium oxide in stainless steel. The arrangement which you see there is somewhat complicated by heavy struts which run from the periphery of the containment vessel to the pressure vessel for stability purposes.



The next slide shows a little bit better the arrangement of the reactor, the turbine, and the main reduction gear on the ship. Also on this chart you can see, at the top left, the space occupied by the direct cycle boiling water reactor in the ship.

What I would like to do now in the light of the time remaining would be to present the results and conclusions of these studies.

First of all, it was determined that the boiling water direct cycle and the pressurized water reactor could be constructed on a 40-month schedule. The indirect cycle boiling water reactor could not. It looks like it required additional development work prior to initiating any kind of construction work in this area.

On the short run, which we will see in the charts which are coming up on economics, the costs of carrying fuel from the Gulf of Mexico to the east coast runs between 22 and 50 percent greater for the nuclear ship as contrasted to the conventional ship. On the longer run and depending upon how you handle the first of kind charges, the nuclear tanker will operate within 3 percent to possibly 35 percent of conventional, depending on reactor types.

I am sure we can clarify this with the charts which I will show shortly.

Representative HOSMER. You say from 3 to 35 percent more?

Mr. GODWIN. That is correct.

Representative HOSMER. Depending on how you do your bookkeeping?

Mr. GODWIN. That is correct. The capital costs for the reference tanker range from 29 to 41 percent greater for the nuclear ship as contrasted to the conventional ship. It looks like with the advancing technology that the nuclear power is rapidly overtaking conventional power in the larger higher powered ships.

We do not have here today charts which depict larger ships, but a ship in the size range of 85,000 deadweight tons would be close to economically competitive at the present time.

May I have the next slide?

NUCLEAR TANKER
COMPARATIVE COST SUMMARY

	FOSSIL FUEL CONVENTIONAL	DIRECT-CYCLE BOILING WATER	INDIRECT-CYCLE BOILING WATER	PRESSURIZED WATER
I CAPITAL COST $1.000				
A. NUCLEAR STEAM SUPPLY SYSTEM	$ 770	$ 4,917	$ 7,017	$ 5,777
B. MAIN PROPULSION & AUXILIARY MACHINERY SYSTEMS	4,773	5,191	5,054	5,267
C. HULL & OUTFIT	10,510	10,671	10,606	10,604
D. COST OF CONSTRUCTION FUNDS (6% PER YEAR)	1,204	1,558	1,700	1,617
TOTAL CAPITAL COSTS	$ 17,257	$ 22,337	$ 24,377	$ 23,265
II ANNUAL OPERATING COST $1.000				
A. FIXED CHARGES (SALARIES, MAINTENANCE, ETC.)	692	733	747	754
B. PORT & CANAL FEES, OVERHEAD & MISCELLANEOUS	175	175	175	175
C. INTEREST, DEPRECIATION & INSURANCE (10% CAPITAL COST)	1,640	2,234	2,438	2,326
D. FUEL COSTS	832	622	651	819
TOTAL ANNUAL OPERATING COSTS	$ 3,339	$ 3,764	$ 4,011	$ 4,074
III MILS / SHP. hr.	3.92	2.98	3.09	3.88
CARGO CAPACITY / YEAR - TONS	267,600	292,000	290,600	289,600
DELIVERY COST / TON - DOLLARS	$ 12.48	12.89	13.81	14.07
IV NON-CAPITALIZED COSTS $1.000				
A. RESEARCH & DEVELOPMENT		2,075	2,150	2,000
B. ENGINEERING REQUIRED FOR FIRST-OF-A-KIND		1,652	2,260	1,930
C. FUEL COSTS IN EXCESS OF EQUILIBRIUM		270	369	
D. CREW TRAINING		200	200	200
E. REFUELING EQUIPMENT COSTS		110	101	74
TOTAL NON-CAPITALIZED COSTS		$ 4,307	$ 5,080	$ 4,204

This is the summary chart of the costs of the fossil fueled conventional ship in the left column, the direct cycle boiling water reactor in the second column, the indirect cycle boiling water reactor in the third column, and the pressurized water system on the far right. The item I is the capital cost of the nuclear ship. You note the nuclear steam supply system, carries the cost of the conventional boilers for comparison purposes. The conventional ship would have the boilers costed at about $770,000 as contrasted to the nuclear steam supply ranging from $4,917,000 for the direct cycle boiling water reactor, to $7,017,000 for the indirect cycle boiling water reactor. The hull is essentially the same for a nuclear and conventional ship. There is not much difference in the ship hulls.

As far as ship stiffening costs are concerned, these are reflected in the main propulsion and nuclear steam supply as are the containment and shielding costs. Thus the added degree of safety does not affect the hull costing.

As a result, you will see that the fossil fuel ship capital costs run about $17 million, as contrasted to the direct cycle boiling water reactor of $22,337,000. Again the indirect cycle boiling water reactor is the highest with $24,377,000.

The annual operating costs, II, include all the other costs which would go toward operating the tanker. We have fixed charges (A) port and canal fees, interest, depreciation, and insurance, and (B) fuel costs. The principal item of interest in this category is that the nuclear fuel costs are less than the fossil fuel costs. For a conventional ship the fuel costs on the reference run, and this happens to be the Persian Gulf run, which is a long run and not necessarily characteristic of U.S.-flag ships, would be $832,000 annually. In contrast, the direct cycle boiling water reactor would be $622,000 annually, which results in a cost in mills per shaft horsepower of 3.92, as contrasted to 2.98 mills per shaft horsepower hour for conventional fuel. The cargo capacity of the nuclear tanker as you will notice is greater. The conventional tanker can carry 267,000 tons per year operating on a use factor of 85 to 86 percent. The nuclear ship on the other hand can carry 292,000 tons of oil per year.

(A tabulation of tanker size and powers, follows:)

ATOMIC ENERGY COMMISSION,
Washington, D.C., April 15, 1960.

HON. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: Enclosed for your information are two copies of a preliminary tabulation of various tanker sizes and powers employed in the Persian Gulf to north of Hatteras trade. Numbers from this table were quoted during the April 6, 1960, hearings on the nuclear-powered tanker design studies.

Sincerely yours,

DWIGHT A. INK,
Assistant General Manager.

Enclosure: Preliminary tabulation (2).

A tabulation of various tanker sizes and powers employed in the Persian Gulf to north of Hatteras trade

[Where practical, the Suez Canal has been utilized]

Ship type	Length	Beam	Draft	SSP (thousands)	Speed	Capital cost (thousands)	Annual operating cost (thousands)	Annual Cargo capacity (tons)	Cost per ton
	Ft.	*Ft.*	*Ft. In.*						
45,000 d.w.t. (study ships), single screw	750	102	37 10	30	18.3	$22,336	$3,764	292	$12.89
45,000 d.w.t., twin screw	760	107	40	60	21.0	29,000	5,335	350	15.20
45,000 d.w.t., quadruple screw	775	115	52	200	30.0	77,000	13,160	500	26.20
60,000 d.w.t., single screw	770	104	44 6	30	18.0	24,400	4,080	414	9.86
60,000 d.w.t., twin screw	800	113	43	60	20.5	30,000	5,500	552	9.95
60,000 d.w.t., quadruple screw	850	131	58	240	30.0	95,000	15,350	665	23.10
85,000 d.w.t., single screw	820	122	46	30	16.5	31,000	4,175	520	8.00
85,000 d.w.t., twin screw	860	131	46	60	19.5	36,000	6,300	612	10.30
85,000 d.w.t., quadruple screw	880	136	60	260	30.0	100,000	18,100	786	23.00
100,000 d.w.t., single screw	900	135	48	30	15.3	34,940	5,268	543	9.70
100,000 d.w.t., quadruple screw	930	137	60	290	30.0	118,000	21,000	925	22.70
100,000 d.w.t., twin screw	895	132	49 4	60	17.5	43,500	6,847	622	11.00
200,000 d.w.t., twin screw	1,000	165	72	73	18.0	55,000	8,400	1,130	7.40

The delivery cost per ton, which is the last figure in III—I should qualify this—that in a ship built in the United States, operating with American crews, and the same reference ship, to carry oil from the Persian Gulf to the United States, would cost in a conventional ship about $12.48. I emphasize that this is a ship built in the United States and operated with American crews. The comparative figure would be $12.89 per ton for the nuclear tanker employing the direct cycle boiling water reactor, which is the lowest cost.

The difference, then, between those figures and the higher figures which I mentioned to you would be the way you would handle IV, the noncapitalized costs. These are the costs of research and development, engineering for first of kind, and the fuel costs in excess of equilibrium. By that we mean the amount of fuel which is removed in the first loading which is not charged off against fuel charges, but appears as a noncapitalized cost.

Representative HOSMER. Doesn't that occur in all your loadings subsequently?

Mr. GODWIN. No; initially we would load a full core of green fuel. When we reach the point of refueling, we would only replace one-third with green fuel in the reactor we are talking about here, the direct boiling water reactor cycle. The indirect, every 2 years we would replace half. The pressurized water does not have that particular figure because we refuel every 2 years but we change the complete core.

Consequently, the research and development costs and first-of-kind engineering would run between $4 and $5 million for the nuclear tanker.

May I have the next slide, please?

COMPARATIVE SHIP COST

PLANT TYPE	Capital $ X 10^6	Fuel Mill / shp.	Operation Less Fuel $ X 10^6	Shipping $ / long ton
BWR-direct	22.3	2.98	3.1	12.89
BWR-indirect	24.4	3.09	3.4	13.81
PWR	23.3	3.88	3.3	14.07
Conventional	17.3	3.92	2.5	12.48

This is a summary of what you saw on the earlier slides. The boiling water direct cycle being on the top, the indirect boiling water reactor and the conventional. The shipping costs per long ton are the significant costs running 3 to 5 percent higher for the boiling water direct cycle as contrasted to the conventional ship, assuming you do not write off the first of kind engineering on the ship.

Dr. WILSON. That is still the Persian Gulf route. It should be emphasized that American-built ships are practically never used on that because they cannot compete with foreign ships.

NUCLEAR TANKER

TRADE ROUTE COST COMPARISON

TRADE ROUTES	FOSSIL FUEL CONVENTIONAL				DIRECT CYCLE BOILING WATER			
	TOTAL CAPITAL COST $ 1,000	TOTAL ANNUAL OPERATING COST $ 1,000	CARGO CAPACITY PER-YEAR TONS	DELIVERY COST $/TON	TOTAL CAPITAL COST $ 1,000	TOTAL ANNUAL OPERATING COST $ 1,000	CARGO CAPACITY PER-YEAR TONS	DELIVERY COST $/TON
PERSIAN GULF-U.S.-EAST COAST VIA CAPE WITH CARGO VIA SUEZ IN BALLAST	$17,257	$3,339	267,600	$12.48	$22,337	$3,764	292,000	$12.89
PERSIAN GULF-U.S.-EAST COAST VIA SUEZ WITH CARGO VIA SUEZ IN BALLAST	$17,257	$3,517	322,300	$10.91	$22,337	$3,957	328,100	$12.06
PERSIAN GULF-U.S.-WEST COAST TRANSPACIFIC	$17,257	$3,188	249,600	$12.77	$22,337	$3,702	267,800	$13.84
COASTWISE TEXAS TO BAYWAY N.J.	$17,257	$3,258	1,421,000	$ 2.29	$22,337	$3,677	1,399,300	$ 2.62

Mr. GODWIN. The next slide, I think, points that out. The next slide depicts the effect of trade route and distance on the relative cost. The first line is the Persian Gulf to the east coast. Those are the figures which you have just seen. The cost of delivered oil for the conventional ship being $12.48, as contrasted to the nuclear ship of $12.89.

The next line would be the Persian Gulf to the U.S. east coast via the Suez Canal both ways. In that instance the conventional ship would be $10.91 versus the direct cycle boiling water reactor of $12.06. The last line which I think is most significant here, coastwise from Texas to Bayway, N.J., for the conventional tanker, the delivery cost would be $2.29, as contrasted to the nuclear cost of $2.62. Again the effects of shorter run become quite obvious. This case is probably more characteristic of U.S.-operated tankers.

Representative HOSMER. I think your next to last line is significant, too, because it takes out the artificiality of canals.

Mr. GODWIN. That is correct.

Representative HOSMER. Obviously when you need these tankers in the Persian Gulf you are probably not going to have the means of returning through the Suez Canal.

Mr. GODWIN. That is right.

Representative HOSMER. If you could ever get them to put one of these through in the first place. Isn't that right?

Mr. GODWIN. That is correct.

Representative HOSMER. Probably your figures for strictly routes without canals are the most significant to read in relation to the cost. They show your fossil fuel is roughly $1.07 per ton cheaper.

Mr. GODWIN. For the conventional; yes.

Representative VAN ZANDT. Mr. Godwin, has your study produced any advantages from an operational standpoint, that is, the continued cruising capability the ship would have?

Mr. GODWIN. Yes. There are advantages to nuclear powered ships to the extent that their logistics are greatly improved. On tankers this is not quite so noticeable. We have done preliminary studies with this same powerplant, BWR, in Pacific liners which we have just completed. In this particular instance, and these figures are far from complete, it shows a Pacific liner with a passenger capacity of 1,450, that the nuclear ship comes out almost exactly the same as the conventional ship at 26 knots. At 31 knots for the transpacific liner, the costs worked out on a per passenger one-way basis, in the nuclear ship, $780 as contrasted to a conventional ship of $793.

The point you make is perfectly valid. The fact that the nuclear ship does not require as much space for its own fuel permits us to build a somewhat smaller ship. So that while the capital costs for the conventional ship are $88 million versus a $91 million nuclear ship, the point is that we can build a smaller nuclear ship to do the same job. This is a different ship type I should emphasize.

Representative HOSMER. You have a problem on your cargo vessels. You use your tanks a lot to trim the ship.

Mr. GODWIN. That is correct.

Representative HOSMER. Where you have a transpacific route where you are going in and out of different ports and taking cargo on and off without the tanks, you may have a little difficulty with the nuclear ship keeping her in trim.

Mr. GODWIN. This was taken into consideration in the figures I have given you here. The ship is somewhat smaller.

Representative HOSMER. Incidentally, I rather quarrel with your assumption in connection with a tanker that you are using a ship that operates at 100 percent capacity. Actually you are using a ship which operates at 50 percent capacity, because you are going out empty and you are coming in full.

Mr. GODWIN. I don't recall saying 100 percent capacity. They usually operate full, but only one way. They deadhead back. You are quite correct in that respect.

Representative HOSMER. On your cargo ship you generally have some cargo in the hold.

Mr. GODWIN. That is correct. In any event in the trans-Pacific liner case, which I mentioned to you just now, this ship can carry its fuel for the round trip. It depends on the market price of the fuel, whether it picks up its fuel in the East Indies, depending upon the route. In any event, these figures assumed fuel loading on both ends. I mention the point merely to emphasize Mr. Van Zandt's observation, that you do gain in other ship applications because of logistics advantages.

Representative VAN ZANDT. Would you make part of the record the statement you read from a moment ago, Mr. Godwin?

Mr. GODWIN. Yes, we will.

(The information referred to follows:)

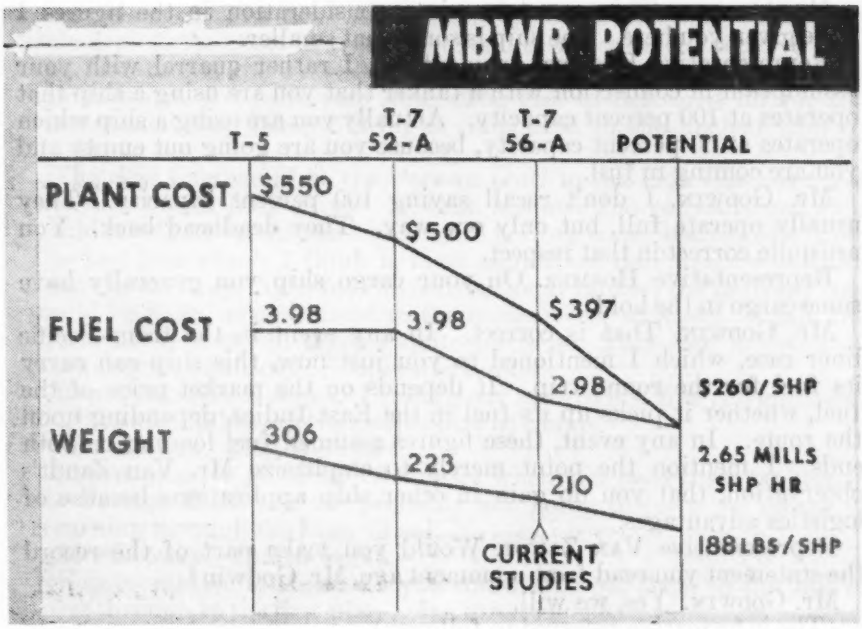
[Preliminary]

Nuclear transpacific liner, passenger capacity 1,450—Comparative cost summary

	26 knots		31 knots	
	Fossil fuel converter	Direct-cycle boiling water	Fossil fuel converter	Direct-cycle boiling water
I. Capital cost, $1,000:				
A. Machinery, propulsion	13,500	11,000	23,000	19,000
B. Machinery:				
Nuclear		8,600		14,400
Secondary shielding		400		600
C. Hull and outfit	67,700	64,200	70,400	64,600
D. Cost of construction funds (6 percent per year)	7,300	7,600	8,400	8,900
Total capital costs	88,500	91,800	101,800	107,500
II. Annual operating cost, $1,000:				
A. Fixed charges (passenger cost, salaries, maintenance, etc.)	9,818	9,758	9,981	9,967
B. Port fees, overhead and miscellaneous	600	600	700	700
C. Interest, depreciation, and insurance	8,408	9,180	9,671	10,750
D. Fuel costs	1,530	1,105	3,477	2,024
Total annual operaing costs	20,356	20,643	23,829	23,441
III. Cost per passenger:				
A. Cargo capacity/year, tons	83,500	83,500	95,000	95,000
B. Annual cargo cost, $1,000 units	726	726	827	827
C. Net annual passenger cost, $1,000 units	19,630	19,917	23,002	22,614
D. Passengers carried/year (80 percent capacity)	25,500	25,500	29,000	29,000
E. Cost per passenger 1 way, dollars	770	781	793	780

Mr. GODWIN. I have, I think, two more slides.

Representative HOLIFIELD. Can you summarize fairly quickly?



Mr. Godwin. Yes. These will summarize the situation with respect to the boiling water reactor and its potential. We have studied over the last 2 or 3 years the costs associated with nuclear power in the tanker. The estimated plant costs have decreased from $550 per shaft horsepower to $397 at the present time, with good potential that these costs can be reduced to $260 per shaft horsepower. Similarly the fuel costs initially were calculated at 3.98 mills per shaft horsepower. It now appears that a figure of 2.98 mills per shaft horsepower is reasonable to expect with the chance that it will be further reduced to 2.65 mills per shaft horsepower with greater burnups and fabrication costs dropping from about $86 per kilogram of fabricated uranium to possibly something in the vicinity of $70. Likewise, the weight of the plant has been reduced from 306 pounds/shaft horsepower to 210 pounds/shaft housepower. Here again this will have a beneficial effect on the cargo capacity of the vessel.

I should emphasize that these figures are for a second of a kind ship. We have not included into these figures the research and development costs.

I should also emphasize that these are relatively small plants for nuclear power. In our view if one were to build a nuclear ship one should stick to the smaller power ranges while we are learning our lessons and not attempt to build larger plants until we have had operating experience with the smaller plants.

Representative Holifield. How about hooking up the smaller plants in tandem?

Mr. Godwin. This is perfectly possible. Unless you had a land-based prototype, you probably would employ the single plant first.

Representative Hosmer. You have an awful weight problem.

Mr. Godwin. The weight penalty is not as severe as you might anticipate. It depends on the cycle. The shielding does not have a

linear effect, because in the tanker you are still relying on cargo to some extent. The pressure vessel is not a large volume absorber. It boils down to the auxiliaries and the space required to get at these auxiliaries to maintain and repair them.

That concludes my presentation.

Representative VAN ZANDT. Mr. Godwin, it is my understanding that the design studies are complete.

Mr. GODWIN. That is correct.

Representative VAN ZANDT. Is it your intention to make a recommendation to proceed with construction?

Mr. GODWIN. This particular aspect is going to be covered by Mr. Allen of the Department of Commerce.

Representative HOLIFIELD. Are there any further questions?

Representative HOSMER. Yes. I want to know about the mass construction of these ships. If you get a war emergency situation like we had in 1941 to 1945, and we had to start building these things by the mile, you could not really mass produce these things in quick time, could you?

Mr. GODWIN. I would say there is no real reason why you could not put the hulls and major portion of the equipment together equally as easily as you would a conventional ship.

Representative HOSMER. I am talking about getting ships to sea.

Mr. GODWIN. At the present state of the art, you are right. We could not do it as rapidly.

Representative HOSMER. Recently the International Association of Marine Underwriters made a recommendation that there be rules established to have absolute liability with regard to nuclear-powered ships, and leave it up to the nation which owns the ship to figure out how to handle that. That presents a very complicated nonengineering problem, does it not?

Dr. WILSON. Not engineering.

Representative HOSMER. Nonengineering.

Mr. GODWIN. Yes. As you know, the IAEA had a convention on the 7th of March in which essentially all the nations were represented and in which they came out with a draft approach to this particular problem. As you say, the approach was one of absolute liability with the governments picking up the major liability for ships of their flag.

Representative HOSMER. I noticed you had some insurance cost factors in there, but they are largely speculative, are they not?

Mr. GODWIN. They are the best figures we can get now from the marine insurance underwriters. But they are limited in the amount of money available. I think $10 million is available at the present time for nuclear incidents.

Representative HOSMER. What percentage of the oil from the Persian Gulf comes to the east coast of the United States on American bottoms?

Mr. GODWIN. I would say essentially none, although Mr. Wilson would probably have the answer.

Dr. WILSON. Essentially none.

Mr. GODWIN. Under the present depressed maritime market I don't think American ships are operating in that particular trade.

Representative HOSMER. As a matter of fact, we never would?

Mr. GODWIN. We have. They did during the emergency situation of Suez, and they have in the past. Here again it depends pretty much upon the market.

Representative HOSMER. That is all.

Representative HOLIFIELD. Thank you very much, Mr. Godwin.

Our next witness will be the Honorable John J. Allen, Jr., Under Secretary for Transportation of the Department of Commerce.

Mr. Secretary, it is a pleasure to have one of our old colleagues before us again, particularly a Californian. We have them outnumbered this morning. Mr. Hosmer and I are both Californians. We have Pennsylvania outnumbered three to one.

STATEMENT OF HON. JOHN J. ALLEN, JR., UNDER SECRETARY FOR TRANSPORTATION, DEPARTMENT OF COMMERCE

Mr. ALLEN. Mr. Chairman, it is a pleasure to be here. I must confess that I don't see many new faces.

Mr. Chairman, I have a short statement that I would like to read into the record.

Mr. Chairman and members of the committee, I appreciate the invitation of the chairman to appear before you today to discuss the programs and policies of the Department of Commerce in the field of nuclear powered merchant ships. The ultimate objective of the nuclear ship program of the Department of Commerce is to develop economically competitive nuclear powered ships for the American merchant marine capable of operating safely in world commerce. The application of nuclear power ocean transport will in our view have broad significance for maritime commerce.

As the report which has just been presented to you through the joint efforts of the Atomic Energy Commission and the Maritime Administration so clearly indicates, there is every reason to believe that in the near future nuclear energy will be competitive with conventional power for ship propulsion, and in the long run has the potential of being a great deal more efficient than conventional power.

The NS *Savannah*, sponsored by the Department of Commerce, will be the world's first nuclear merchant ship. While it was not anticipated that the *Savannah* would be competitive to build and operate, it should prove out the feasibility of the application of this type of power to commercial shipping.

In addition, the existence of this ship will aid in the solution of many practical problems and pave the way for general acceptance of nuclear shipping.

We in the Department envision this ship, the NS *Savannah*, as only the beginning. Reductions in construction and operating costs to the point where nuclear energy will be competitive with conventional power can best be achieved by advancement of design technology and through the application of building and operating experience.

The boiling water reactor systems portrayed today are significant steps forward and the gas cooled system now under development offers even greater potential for the more distant future.

There is no doubt in my mind, gentlemen, that the United States should continue its forward looking program in this field. I am convinced that nuclear power and other technological improvements

that have appeared on the horizon offer the American merchant marine a unique opportunity to regain its strength and reassert itself in world maritime commerce.

The Department of Commerce, therefore, to the extent of the resources made available to it, will continue its research and development in nuclear energy and will proceed as rapidly as possible with the application of advanced nuclear power systems for merchant vessels.

Representative HOLIFIELD. Thank you, Mr. Secretary.

Representative VAN ZANDT. Mr. Allen, on page 1 you say there is every reason to believe that in the near future nuclear energy will be competitive with conventional power. Could you give us an estimate in years?

Mr. ALLEN. It would be a guess. I would think from the fact that some of the oil companies, for example, have been looking at the potential of building a ship for their own purposes with more or less Federal assistance would indicate, 2, 3, 4, 5, 6 years, within the realm of possibility. I could not be much more certain.

Representative VAN ZANDT. Returning to the question put to Mr. Godwin a moment ago. He was asked the question whether or not the design studies have all been completed. I think he said yes. Then I asked him if he was ready to make recommendations for ship construction. He said he would rather leave that to you. Therefore, this question, "Does the Department of Commerce have any plans to start construction since the design studies are complete?"

Mr. ALLEN. The Department has plans in a sense. I would not say that they are plans that outline a definite procedure. In the consideration of the application of nuclear power to shipping, one of the first questions, of course, was the operation of the *Savannah* and what it would prove and what problems would be settled by its operation.

The next problem was when further steps should be taken and in what direction they should be taken. Whether the Government should build a tanker and operate it for its own account, or build some ship and operate it for its own account was a problem that I think was pretty well settled. It seemed to be the opinion or the consensus of opinion in the Department, consistent with its subsequent actions, that the stage had been reached where private industry should be brought into the picture, and the next endeavor insofar as Commerce is concerned should be a cooperative one or one carried on by private enterprise.

As to the amount of cooperation between Government and private enterprise, and as to the timing, there is no decision. I would think that no one has reached the point of deciding that private enterprise would go ahead on its own without assistance. Somewhere in that field is where we will make the next decision. I would think that the timing as to the cooperative program and the amount of assistance that would be required before private enterprise would go ahead with its part.

Representative HOLIFIELD. In the face of more than a dollar a ton penalty, as shown by the studies there, which would amount on a 300,000-ton fuel oil load to a loss of nearly $300,000 a trip. Under those figures, it would be highly improbable that any tanker operator would assume that penalty in order to have a nuclear-propelled vessel, would it not?

Dr. WILSON. I think that there is something wrong; $300,000 per year.

Representative HOLIFIELD. Was that annual?

Dr. WILSON. Yes.

Representative HOLIFIELD. No, I understood that Mr. Godwin's comparison was on the basis of one shipload. Is Mr. Godwin still here?

Mr. GODWIN. No, those were annual costs.

Representative HOSMER. I wonder if the Secretary would state for us who operates the commercial tankers under American flag on oversea routes?

Mr. ALLEN. I missed the first part of your question.

Representative HOSMER. Who is operating commercial tankers under the American flag on oversea routes?

Mr. ALLEN. I would think almost no one except an occasional trip by an American oil company.

Representative HOSMER. We are certainly talking to nothing here, aren't we?

Mr. ALLEN. No, I don't think so. The studies we have had of the merchant marine in the last few months, one the Walrus report and one the transportation study of the Department, indicate that the research and development programs are essentially then to lead the merchant marine under the American flag back into a competitive position. There is nothing wrong with the American operators if you consider the fact that when American operators are operating under equal competitive conditions, they do as well as anybody. When they operate under the foreign flags they do as well as anybody. It is quite possible, in my opinion, that the research and development program that is involved in this discussion before the committee today can go a long way toward removing the difference between American-flag and foreign-flag operations. So we would have the same people involved, and they would rather operate under the American flag, if it were economically feasible.

Representative HOSMER. But you are building up a fleet of ships that are essentially house ships. Socony, Esso, and a few more of the big operators carry their own oil. Maybe national bulk carriers and whatever American subsidiaries the Greeks have. Those are the only people who are going to do this thing, and they are not going to do it on what we regard as a healthy merchant marine basis. They are going to do it on their own internal facility basis.

Mr. ALLEN. I would be inclined to question that, at least to an extent. For one thing, we don't know the extent to which this present research and development and the stage it has now reached can take us in the realm of such things as mechanization and automation on the propulsion system. We don't know how far it can affect the conditions of the navigating and the deck force.

Representative HOSMER. You don't really think we are going to be carrying some other country's oil in any of these ships?

Mr. ALLEN. No, we are going to carry oil owned by American oil companies, certainly.

Representative HOSMER. That is the benefit that the big oil companies with heavy oversea holdings will get.

Mr. ALLEN. Of course, if we carry oil, it will be for the oil companies, because they have the oil. Secondly, I doubt that we should

consider that this development is applicable only to tankers. I think that is another phase of development that can well change the economic feasibility of the use of nuclear power. There are already ships in existence which are attempting to be bulk carriers of oil and grain as well as tankers. There are possibilities of reconsidering the trade routes for a certain type of ship. It is not too far beyond question that some more efficient use of a ship on the basis of trying to keep it loaded while it was at sea could be established by changing the routes they travel. There are many things of that sort that are in the stage of development. The matter of handling cargoes in and out of ships is another great phase for coordination with this effort in making the merchant marine more competitive.

We already have more ships that are capable of carrying containerized loads, heavy lift, quick turnaround, and lower costs of handling cargo, than any other nation and we are probably going to keep ahead of them on that phase of it.

Representative HOSMER. We got into this business on tankers because of the quick turnaround and because of the high percentage of time at sea originally. We forgot about a lot of these other factors; who owns the tankers, and what they do with them. I have no objection to going into other fields. I don't think the tanker is a logical place to concentrate a nuclear propulsion plant for a number of political, social, and economic reasons, and whatever else we scrape out of the bottom of the barrel.

Mr. ALLEN. I think you are probably right. From my viewpoint it seems to me that the use of the tanker on a specified run to be built in a specified time and to be of a certain size was primarily of importance because it gave a standard background against which to compare three types of reactors, or maybe four. We have that comparison and it gives some basis for knowing which reactor to use in whatever ship would be the potentially available for economical use.

Representative HOSMER. That is true. But you are taking it on an entirely hypothetical route and comparing it against American-flag vessels which do not operate on this route.

I will yield to the Senator.

Senator JACKSON. Thank you. I have to go to answer a live quorum.

I wonder if we could have supplied for the record, Mr. Allen, a statement on the overall situation that prevails in the oil industry today worldwide, including the number of tankers that are already laid up. From what I read in the newspapers, I have the impression that the oil industry, compared with other industries, is a bit sick. They talk constantly about world surpluses, although the average rate of consumption, I think, worldwide, is increasing about 5 or 6 percent. Standard of New Jersey's president has a statement in the New York Times this morning applying to the industry, and he indicated that it does not look too good for the period ahead. I am just wondering whether the economics of the situation are such here that a nuclear-powered tanker is feasible.

Mr. ALLEN. We have the prediction that there is a surplusage of tankers now, but within 3 or 4 years it is expected to be reversed. These ships are 4, 5, 8 years hence.

Senator JACKSON. I understand that. But more and more oil is coming into the world market and new fields are being opened, the

latest being in North Africa. I am just wondering whether or not the timing here in connection with this proposal is such that it can be justified. I just raise the question.

Mr. ALLEN. I think that is one reason that the Department has not come to a conclusion as yet.

Senator JACKSON. Mr. Chairman, I will be back in about 5 minutes.

Representative HOLIFIELD. I would like to summarize these figures, if they are correct, in view of the fact that I misunderstood the figures I mentioned a few minutes ago as being per trip, and it was annual.

I find in looking at table 3 on page B–14 of the study that the conventional cost as compared with the three nuclear studies or the three nuclear types of propulsion is as follows:

The direct cycle boiling water in the table under column B which is adjusted value, shows that the annual cost would be $425,400 greater. In the indirect cycle, boiling water, under column B, $771,900 more costly annually. In the pressurized water, under column B, $735,200 more costly. Does that agree with your concept, Mr. Godwin?

Mr. GODWIN. Yes; that is about right.

Representative HOLIFIELD. Thank you very much, Mr. Secretary. We have three contractor representatives here this morning, Dr. Lyman R. Fink of the General Electric Co., which made the design study for the direct-cycle boiling-water reactor; Mr. J. W. Simpson and Mr. G. H. Farbman of Westinghouse; and Dr. P. C. Zmola, Combustion Engineering. We will invite each of you forward to make a short summary of your statement and file your complete statement for the record as we are running behind this morning. We want your statements more for the comparative value in the record, and we are not planning to question you on your studies, because we have not had them long enough to study them.

We will have Dr. Lyman Fink of General Electric come forward at this time.

Dr. Fink, we will accept your statement for the record, so will you please summarize your statement?

STATEMENT OF DR. LYMAN R. FINK, GENERAL ELECTRIC CO.

Dr. FINK. We understand the pressure of time. Thank you for the brief moments.

I am accompanied by our project engineer on the study, Mr. Voorhees. I want to endorse for the company's management the technical work of our people and subscribe to their report and subscribe to the excellent comparative report prepared by the Commission and say we stand ready, as a company, to participate to the degree and to the extent that the Commission would like to call on us to participate in the furtherance of this program. We are prepared to take on any questions, if you like, but we understand you are pressed for time.

Representative HOLIFIELD. Thank you very much, Doctor.

(The statement referred to follows:)

STATEMENT OF DR. LYMAN R. FINK, GENERAL MANAGER, ATOMIC PRODUCTS DIVISION, GENERAL ELECTRIC CO.

I

Let me begin by thanking the committee for this opportunity to present General Electric's views on the marine boiling-water reactor for merchant-ship application. As you know, General Electric has been studying this reactor for some time under contract with the Atomic Energy Commission. In December we submitted to the Commission a detailed report of the results of the study. My statement today will cover briefly some of the principal points made in the report.

I don't believe I need to enlarge on General Electric's experience with boiling-water reactors. The report which we submitted in December is based on extensive work on the application of this reactor to merchant ships. This work has been carried on for over 2 years under two study contracts with the Commission.

Our atomic power equipment department additionally designed and built the control rod drive mechanisms and portions of the control system for the NS *Savannah*. It has also developed and is currently fabricating a second core loading of fuel for the *Savannah*.

The particular design described in the report is for a 27,300 shaft horsepower direct cycle boiling water propulsion system in a 44,000 deadweight ton tanker. The economic analysis is for a specified run between Philadelphia and the Persian Gulf.

In carrying out its work on the marine boiling water reactor, General Electric worked closely with personnel of the Commission and the Maritime Administration, who supplies the design criteria and did the marine architecture work for the ship and the propulsion system. Our scientists and engineers have drawn on the established boiling water technology. In addition they have carried on substantial experimental work in support of the design effort.

II

The company's 2-year program on marine boiling water reactors has accented progress in plant weight, in performance, and in capital, fuel, and operating costs. Major efforts have included these:

1. Reactor core designs permitting maximum core volume and equipment costs.
2. Control system strength permitting high fuel burnup.
3. Fuel element design improvements including unsegmented fuel rods clad with thin-wall stainless steel tubing.

Each of these three features will be tested in the modified Vallecitos boiling water reactor soon after its startup, which is presently scheduled for May 15.

4. The proposed system design uses internal steam separation. This permits elimination of the external steam drum and of extensive piping as well as reduction of the size of the containment vessel, and greater plant compactness. General Electric has been conducting internal steam separation tests for several months.
5. Relying on computer techniques and advances in shield theory, an improved shielding design permitting substantial weight reduction has been developed.
6. Control systems adequate to meet or excel maneuvering characteristics of conventional ships have been designed and partially tested.
7. Designs have been delineated for detecting and controlling the consequences of sea water leakage at the condenser including the use of full flow condensate demineralizers.
8. Our engineers have carried on extensive analytical and experimental work on the effects of ship motion.

They have employed the analytical tools developed to predict the dynamics of boiling water reactors, which are increasingly well understood. An initial step was to define the extremes of ship motion which might be encountered in rough seas. These motion conditions were then applied as inputs or disturbances in the analyses to obtain computer traces of the fluctuations which would occur in reactor output.

The analytical work has been accompanied by an experimental program. Our engineers have obtained heat transfer and flow stability data from 45° inclined channels. Additional data are now being obtained from a rocking loop which exposes the test elements to varying acceleration.

III

Let me state now some conclusions based on the work which General Electric has carried on:

1. It is our conviction that a safe and reliable powerplant utilizing the direct cycle marine boiling water reactor proposed in the company's report, can be designed and built now, and that it can be completed within 3 years after the beginning of design and construction, that is by 1963, if we proceed expeditiously. The application of nuclear power in the merchant marine field is new. It will be necessary to develop internationally accepted safety criteria for the operation of nuclear ships and to pay careful attention to safety in design and construction. Appropriate international conventions on liability must also be established, of course.

2. The design and development work has reached the stage where significant further improvements can best be made by designing, building, and operating a ship.

3. The effects of ship motion on boiling water reactor performance is the principal area where we do not yet have complete answers. All the analytical and experimental results obtained thus far are in agreement; they indicate that the effects of ship motion should not be severe. Final answers can come only after operation of a ship.

4. The construction of a complete land-based prototype would result in appreciable loss of time and a significant increase in price of the project. For a nonmilitary aplication, many of the advantages or requirements for prototypes are not important. Major test facilities will be used to simulate certain of the systems in which experimental confirmation of design is considered necessary. It is our opinion that a prototype is not necessary for this application.

It should be noted that the Pacific Gas & Electric turbine, generator, and associated equipment now coupled to the Vallecitos boiling water reactor were originally installed in a T–2 tanker with a conventional steam supply.

5. This brings us to the key question of economics. The company's report contains capital, fuel and operating cost estimates. These estimates have been based on criteria supplied by the Commission and the Maritime Administration. Similar criteria have been supplied to contractors studying two other types so that all the estimates will be on the same basis. I understand that the Commission is submitting a report comparing the cost estimates for each of the three types.

There has been no reliable test of the economics of our design or of any of the other designs proposed. Hence our cost estimates involve an element of judgment. We have tried to make the judgments fairly and reasonably. The cost estimates in the report were developed by the same methods employed in the company's commercial work. They are supported by the company's boiling water reactor experience to date, and by the data developed in our studies for the Commission.

The proposed plant will fall short of being competitive with conventional ships. It should have about a 5- to 10-percent greater cargo carrying capacity for the same deadweight tonnage and more favorable fuel costs, but these will not fully offset higher capital costs. However, the experience gained from construction and operation of the first ship, plus general advances in boiling water technology, should make it possible to design and build a follow-on ship with improved capital, fuel, and operating costs. This follow-on ship should be competitive in certain applications with one using a conventional propulsion system.

I recognize that there are uncertainties in the application of any reactor system to a merchant ship, but I am confident that this tanker project entails less technical risk than other projects which General Electric has undertaken in

the field of atomic energy. When we consider the attractiveness of the goals and the probability of success, we believe that there is ample justification for going ahead.

Representative HOLIFIELD. Mr. J. W. Simpson and Mr. G. S. Farbman of Westinghouse Electric Corp.

STATEMENTS OF J. W. SIMPSON AND G. S. FARBMAN, WESTINGHOUSE ELECTRIC CORP.

Mr. SIMPSON. Thank you, Mr. Chairman.

Representative HOLIFIELD. Mr. Simpson, will you please summarize your statement?

Mr. SIMPSON. We have been pleased to have been selected as one of the contractors to perform the evaluation of alternate nuclear propulsion systems for tankers. It is our hope that the work we did will serve to advance the technology of nuclear-powered ships and speed the day when reactors will power our merchant fleet.

We fully realize that the indirect-cycle boiling water reactor which was the reactor type assigned to us is not competitive with conventional marine powerplants, having a capital cost sufficiently higher than conventional to outweigh the advantage of nuclear over oil fuel costs, that is.

However, the data and concepts resulting from this study should be of use to the industry as a whole. In conclusion, may I say that Westinghouse is extremely interested in nuclear propulsion and will continually expend efforts toward attaining economically competitive marine nuclear powerplants. We fully intend to assist the Commission in any of their programs toward this end.

Representative HOLIFIELD. Thank you very much, Mr. Simpson. Your statement will be received for the record.

(The statement referred to follows:)

STATEMENT OF WESTINGHOUSE ELECTRIC CORP. SUBMITTED BY J. W. SIMPSON AND G. S. FARBMAN

Westinghouse was pleased to have been selected as one of the contractors to perform the evaluation of alternate nuclear propulsion systems for tankers. It is our hope that the work we did will serve to advance the technology of nuclear-powered ships and speed the day when reactors will power our merchant fleet. We fully realize that the indirect-cycle boiling-water reactor, which was the reactor type assigned to us, is not competitive with conventional marine powerplants, having a capital cost sufficiently higher than conventional to outweigh the advantage of nuclear over oil-fuel costs. However, the data and concepts resulting from this study should be of use to the industry as a whole.

I have the following brief comments on the Commission's three design studies for selecting a prototype reactor for a nuclear tanker:

The report concluded that the direct-cycle boiling-water reactor, because of its lower capital and operating costs, and because of its greater future potential, would be the most likely system to achieve competitive power in the near future. It would seem appropriate to point out that, although the direct-cycle boiling-water reactor has the potential of some real advantages, there are a number of technical problem areas which must be cleared up before such an application could be made with real certainty. These problem areas will take extensive development programs and possibly prototype operation for solution. Some of the main problem areas are as follows:

1. Operation of the plant on board ship: The effects of pitch, roll, and heave on the operation of a natural circulation system has not been fully evaluated. The hydraulics and reactivity feedback cannot be satisfactorily determined analytically, for in order to do the analysis a number of simplifying assumptions must be made which result in grave uncertainties in the results.

2. Radioactive carryover: Machinery space in the direct-cycle boiling-water reactor are limited access areas due to the induced activity in the steam. However, a larger problem results from the question of the integrity of fuel elements over long operating times and the attendant particulate radioactive carryover in the event of fuel failure. The statistics of fuel-element failures have not been determined and will not be until reactors with large quantities of fuel, produced on a commercial rather than laboratory basis, are operated for long periods of time. Particulate radioactive carryover to the machinery space will necessarily handicap the operation of the ship and probably result in extended downtime of the plant.

3. Leakage of sea water into reactor: In the direct cycle plant, there is always the problem of leakage of sea water through the condenser into the reactor coolant. Sea water, with its high chloride content and spectrum of other elemental constituents, provides a potential hazard to the reactor system. The chlorides greatly enhance the stress concentration problems in the reactor components, while the other constituents of the sea water provide a source for radioactive contamination. The use of full flow condensate demineralizers to eliminate this problem involves additional development over the demineralizers used in land-based direct-cycle boiling water reactors, where fresh water, rather than sea water, inleakage must be cleaned up.

For immediate application of nuclear power aboard ship, it would appear that the indirect cycle pressurized water reactor would still be a logical choice. Much more experience has been accumulated on this type than on any other type. The safety aspects related to possible contamination in the close confines of a ship are clearly better on the closed cycle reactor than on other types. The problems of pitch and roll affecting the operation of the reactor have already been met and resolved. The same is not the case for the direct-cycle boiling water reactor.

From a cost standpoint, there is always room for discussion. One has to keep in mind that the most experienced reactor is the one for which the costs can be predicted with greatest accuracy. Less experienced reactors have historically always had lower costs as the estimators view the future of these reactors with optimism.

Finally, from an operation viewpoint, the pressurized water reactor, with its well-defined and developed technology, affords a powerplant which gives the maximum ship availability at the same time that it provides an inherently safe, stable, and load following powerplant.

In conclusion, may I say that Westinghouse is extremely interested in nuclear propulsion and will continually expend effort toward attaining economically competitive marine nuclear powerplants. We fully intend to assist the Commission in any of their programs toward this end.

Representative HOLIFIELD. Dr. Zmola, Combustion Engineering.

STATEMENT OF DR. P. C. ZMOLA, COMBUSTION ENGINEERING, INC.

Dr. ZMOLA. I would like to make a technical comment with regard to the pressurized water system for this application, and that is that one of the features which it has, which the other systems do not, is what you might call a natural intelligence; that is to say, because you have water at relatively high temperature and the density and hence reactivity decreases rapidly in this range, it is possible to have self-regulation simply from the control of the system.

This is one of the features, actually, that made people stay with pressurized water systems in the early stages. I think you will see

from the studies that from the standpoint of capital costs the system is comparable to any that we might build within the ground rules, particularly the 40-month schedule.

As far as fuel costs are concerned, I think there again we have relatively little experience to really assert precisely what these fuel costs will be. We make studies and sometimes one of the largest variables is to the people who make the study.

Therefore, until we do have some experience along this line I think we must be very careful in interpreting a series of numbers that one might look at and then try to draw conclusions just on operating costs.

In any event, we feel the system that has evolved as the pressurized water system within the ground rules of study is one that should be seriously considered for construction provided, of course, the motivation is there, about which we are not prepared to comment at this time.

I would want to say that we were pleased very much to do the study for the Commission. I would like to read a part of a letter from our management to Mr. McCone, as follows:

Under the assumption that suitable arrangements could be made with a ship construction whereby the nuclear steam supply system would be integrated with propulsion equipment into the ship, our company is prepared to enter into an agreement with the Government to supply the reactor steam system under any contract arrangement, including a fixed price.

Representative HOLIFIELD. Thank you very much, Dr. Zmola.

(The contractors' responses regarding nuclear powered tanker design studies follow:)

ATOMIC ENERGY COMMISSION,
Washington, D.C., April 15, 1960.

HON. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: In accordance with your request, there are enclosed copies of our TWX and the three contractors' responses regarding their company position concerning the costs reported in the nuclear powered tanker design studies.

Sincerely yours,

A. R. LUEDECKE,
General Manager.

MARCH 16, 1960.

COMBUSTION ENGINEERING, INC.
Nuclear Division,
Windsor, Conn.
(Attention Paul Zmola).

GENERAL ELECTRIC CO.,
San Jose, Calif.
(Attention Robert Voorhes).

WESTINGHOUSE ELECTRIC,
Pittsburgh, Pa.
(Attention Jerry Farbman):

As you are aware, costs resulting from recent nuclear tanker studies show a substantial improvement over past marine nuclear application study. In order to confirm the validity of the costs presented in your study report, it is re-

quested that you submit a statement from a responsible company official to John A. McCone, Chairman, USAEC, stating—

(1) Outline of your company position with respect to the accuracy of cost data presented in your study report particularly those items of cost pertaining to the nuclear steam supply system;

(2) Guarantee of fuel fabrication costs;

(3) Warranty on plant output and fuel exposure.

W. A. HEPBURN,
Chief, Technical Programs Branch, Division of Reactor Development.

WASHINGTON, D.C.

COMBUSTION ENGINEERING, INC.,
NUCLEAR DIVISION,
Windsor, Conn., March 29, 1960.

MR. JOHN A. MCCONE,
Chairman, U.S. Atomic Energy Commission,
Washington, D.C.

DEAR MR. MCCONE: At the request of Mr. W. A. Hepburn of the Maritime Reactors Branch, we are pleased to comment directly to you on the validity of the costs developed in our recently completed design study of a pressurized-water reactor for a nuclear-powered tanker.

The cost data presented in report NYO–2860 were developed jointly by Combustion Engineering, Inc., and George G. Sharp, Inc., to ground rules provided by the Commission. In particular, the cost estimates for the nuclear steam supply were based on our latest experience and were established in a manner consistent with the normal procedures used by Combustion Engineering, Inc. in preparing proposal contract estimates.

It should be noted that the cost estimate emphasized in the study was for a second-generation tanker, and we assume that the Commission is, in fact, interested in an expression by our company of the price of a first plant. The first-plant estimate, also given in the study, differs from the second generation plant estimate by the inclusion of additional component, engineering, and R. & D. expense.

Under the assumption that suitable arrangements could be made with a ship constructor whereby the nuclear steam supply would be integrated with propulsion equipment into the ship, our company is prepared to enter into an agreement with the Government to supply the reactor steam system under any contract arrangement, including a fixed price. We would warrant the plant output and fuel exposure to the design conditions given. We would be prepared to fabricate the fuel at the price which was indicated in the study, which was applicable to January 1960. All prices, of course, would have to be reviewed to reflect the actual date of placing an order.

As an indication of our confidence in our cost estimating procedures, you may note that we have recently made a fixed price bid to the Atomic Energy Commission for the design and supply of a nuclear steam system (SPWR) whole size and general requirements are similar to the reactor system specified in the tanker study report.

Yours truly,

W. N. ZINN, *Vice President.*

MARCH 23, 1960.

Hon. JOHN MCCONE,
Chairman, U.S. Atomic Energy Commission,
Washington, D.C.:

As you know we have recently completed a preliminary design and economic evaluation for a direct cycle boiling water reactor powered 44,000 DWT tanker. I have examined the results of this study and wish to convey our feelings of confidence in the accuracy of the data contained in the summary report.

The capital and operating costs were prepared jointly by CE and the Maritime Administration in conformance with the ground rules for the study specified by the Commission. Based on our experience on a number of commercial undertakings we believe that the overall cost estimates for the complete propulsion system are in agreement with cost figures which we have developed for comparable central station boiling water reactors. For the nuclear steam supply system the direct costs of equipment and services supplied by CE were estimated

in accordance with our esablished cost estimating practice and experience. As such the cost estimates are accurate and will provide a reliable basis for evaluating the economic potential of the marine boiling water reactor. The fuel fabrication costs shown in our report are based on planned costs for fuel delivered in late 1963.

With respect to warranties we have somewhat different circumstances than for land-based plants. Nevertheless we are prepared to warrant the fuel fabrication costs in line with those costs shown in our report.

In addition we are prepared to warrant the plant power output based on a reasonable operating period and under reasonable operating conditions. With respect to fuel exposure warranties we are concerned about the lack of data as to the effect of the dynamics of a marine reactor on fuel performance. The effect of ships motion, rapid and frequent changes in power level, and the difficulty of our specifying and following closely conditions under which the fuel would be operated make us believe that it would be unwise to commit ourselves to an exposure warranty at this time. As additional development results become available we would be willing to negotiate a reasonable fuel exposure warranty based on enrichment provided. Favorable results to date provide a basis for believing that fuel performance should not be subtantially different from that on land-based plants but we believe it premature at this time to make a firm warranty.

I can assure you that we are prepared to commit the necessary manpower and facilities to insure successful attainment of the Commission's objectives. We have confidence in the future of the direct cycle marine boilng water reactor and we would welcome the opportunity to continue our participation in the development of this propulsion system.

Very truly yours,

GEORGE WHITE,
General Manager, Atomic Power Equipment Department, General Electric Co.
SAN JOSE, CALIF.

WESTINGHOUSE ELECTRIC CORP.,
Pittsburgh, Pa., March 25, 1960.

Subject: AEC contract At (30-1)-2176 Task VII—Nuclear tanker study.

Hon. JOHN A. MCCONE,
U.S. Atomic Energy Commission,
Washington, D.C.

DEAR MR. MCCONE: This letter is in response to a wire received from Mr. W. A. Hepburn of the Atomic Energy Commission on March 16, 1960, requesting information related to the subject nuclear tanker study.

Our comments on the three specific questions raised in this wire are given below numbered as they appeared in Mr. Hepburn's wire:

1. The estimate of cost for the nuclear steam supply system, contained in our report WCAP-1340, was based on the best information available at that time and is in accordance with our current practices for preparing competitive proposals. We feel that the estimate is entirely sound in terms of today's dollars. The Atomic Power Department of Westinghouse has had considerable experience over the past 5 years in conducting similar studies on water reactor systems.

2. Westinghouse would guarantee the fuel fabrication costs in this report, subject to normal price escalation for changes in labor and material indexes. Naturally, we cannot be responsible for the elements of fuel costs beyond our control.

3. Westinghouse would warrant the output of the plant described in the study. We would also warrant the fuel burnup of the equilibrium core at 11,820 MWD/tonne with replacement of fuel to be made on a battery formula.

Sincerely,

(S) CHARLES H. WEAVER,
Vice President.

Representative HOLIFIELD. At this time we will take up the remote military installation part of our hearings. Col. D. G. Williams, Assistant Director for Army Reactors, Division of Reactor Development, will be our witness.

STATEMENTS OF DR. ROBERT E. WILSON, COMMISSIONER; A. R. LUEDECKE, GENERAL MANAGER; COL. DONALD G. WILLIAMS, REACTOR DEVELOPMENT, ATOMIC ENERGY COMMISSION

Representative HOLIFIELD. Mr. Floberg, did you wish to lead off?

Mr. FLOBERG. General Luedecke has a short leadoff statement and he will introduce Colonel Williams.

DESIGN STUDIES FOR REACTOR FOR REMOTE MILITARY INSTALLATION

General LUEDECKE. Mr. Chairman, under the 1960 authorization the Commission undertook design and engineering studies on reactors suitable for remote military installations. We approached this problem by requesting that the Department of Defense designate for us those remote military locations having power requirements in the period 1963 to 1967 in the range of 5 to 40 megawatts.

Kaiser Engineers was selected to perform studies on the remote locations which we designated to them. The Kaiser reports have been submitted to the committee, as well as the comments of the Commission in their evaluation of that report. In light of the time element, I would ask Colonel Williams to proceed with the presentation.

Colonel WILLIAMS. Mr. Chairman, I would like to make one thing clear. The choice for the reactor types for the various applications in this study should not be construed as the preference of the Commission in any particular case. The choice was limited to pressurized and boiling-water reactors based on the existing state of the art and the final choice for each site was based primarily on the availability of existing designs for the reasons that this would give us more realistic cost estimates and that it would be more economical to adapt or modify slightly an existing design than to design a new reactor.

If a decision were made to proceed on any one of these particular projects, the ultimate design might or might not be the same as that chosen by the contractor in the study.

The Department of Defense can be expected to appraise the economics of nuclear power in terms of costs for which the Department of Defense must budget. Therefore, the study was made on that basis—Department of Defense costs.

TOTAL PROJECT COST	ANNUAL DOD BUDGETED COST	COST OF POWER TO DOD
COST INCLUDES:		
1. DESIGN ENGINEERING 2. DIRECT CONSTRUCTION COSTS (Includes Test Operation) 3. INDIRECT CONSTRUCTION COSTS 4. ESCALATION (2%/yr) 5. GOVERNMENT COSTS (6% of Total Less Contingency) 6. CONTINGENCY (12% Nuclear, 8% Conventional Except 15% for McMurdo)	1. OPERATING & MAINTENANCE COSTS (Labor, Spares, Escalation) 2. NUCLEAR FUEL COSTS (Fabrication, Burn-up, Reprocessing) 3. FUEL OIL COSTS (Average Commercial Price Over 20 Years)	1. 5% DEPRECIATION PER YEAR 2. ANNUAL DOD BUDGETED COST
COST DOES NOT INCLUDE:		
1. LAND 2. TAXES 3. INTEREST ON INVESTMENT 4. INSURANCE	1. FUEL USE CHARGE 2. TAXES 3. INTEREST ON INVESTMENT 4. INSURANCE 5. PROFIT	

May I have the first slide, please? You do not have this in the handout. This information is, however, included in the letter which was transmitted to you recently by the Commission.

(The letter referred to follows:)

ATOMIC ENERGY COMMISSION,
Washington, D.C., March 31, 1960.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: In section 113 of Public Law 86-50 the Commission was directed to undertake design and engineering studies of a reactor for remote military installations. As outlined in our letter of September 1, 1959, our approach was as follows: (1) the Department of Defense (DOD) provided foreseeable 5 to 40 megawatts electric power requirements at remote installations in the period 1963-70; (2) a contractor developed designs and cost estimates for nuclear and conventional plants for 10 applications for which nuclear power would compete most favorably with conventional power; (3) the DOD indicated which applications would be of most interest to the DOD considering costs and all other factors deemed appropriate.

From among eight firms proposing to perform the study, Kaiser Engineers was selected, and a contract was executed as of August 17, 1959.

The choices of reactor types for the various applications should not be construed as a preference by the Commission for one particular concept over another. The choice was limited to pressurized and boiling water reactors based on the existing state of the art, and the final choice for each site was based primarily on the availability of existing designs for two reasons: (1) more reliable cost estimates available from vendors, and (2) more economical to adopt or modify slightly an existing design than to design a new reactor. If a decision were made to proceed with any of these particular projects, the ultimate designs might or might not be the same as reflected in this study.

The DOD can be expected to appraise the economics of nuclear power in terms of costs for which the DOD must budget; therefore, the study was prepared in these terms. Specifically, the cost estimates do not reflect interest on the investment and fuel use charges; therefore, they do not represent total costs to the Government. Furthermore, because they do not include cost of land, taxes, indemnity insurance, and return on investment, the figures should not be compared to commercial costs.

Enclosure 1 hereto summarizes Kaiser's cost estimates and reflects revisions to those estimates based on our evaluation of the Kaiser figure. The estimated total project costs include, in each case, Government costs to cover such items as contract administration, resident engineering services, and Government travel. In a Commission construction project, such Government costs would have to be provided for in the operating budget. Enclosure 2 reflects our technical evaluation of the study and provides details of our evaluation of Kaiser's cost estimates.

In our evaluation of the study, we found only one cost estimate with which we differ to an extent that has an important impact on the overall result: the vendor's estimates for the plant at McMurdo Sound omitted several significant items. These have been called to the vendor's attention and he has confirmed the accuracy of the adjustments made by our evaluation. For our revised estimates we have used the higher, more conservative figures, and the effect is reflected in enclosure 1. It should nevertheless be emphasized that the Commission does not regard the estimates in this report as guaranteed prices inasmuch as they are based primarily on vendor estimates rather than bids.

Our technical evaluation of the study has disclosed but one major deficiency: the nuclear and standby systems designed for Thule Air Force Base will not meet the requirements of the Air Force for that installation. Specifically, the use to which the power will be put makes it mandatory that power be available on a continuous basis; however, inherent in Kaiser's recommended system there is a potential outage of 2 minutes which is the time required for the standby system to pick up the load and which would occur any time the nuclear plant shut down without at least 2 minutes of advance warning. The technical changes necessary to overcome this deficiency and the cost of such changes are being investigated further.

There is one fact concerning the plants for the Nike-Zeus application which should be noted. The system reported is adequate to meet the power requirement as stated to the contractor; however, subsequent changes in the Nike-Zeus concept indicate that greater power of a higher quality may be required. Therefore, because the ultimate power requirements for Nike-Zeus installations are still uncertain, the cost estimates for nuclear power at Nike-Zeus installations must necessarily be uncertain also.

Because of time limitations, the DOD was requested to determine its relative interest in the 10 applications on the basis of the unevaluated study results. Although the estimates have changed somewhat as a result of our subsequent evaluation, we are confident that such changes would have had no effect on the position reported by the DOD.

The DOD has indicated the following order of interest in the applications investigated: (1) McMurdo Sound, (2) Thule Air Force Base, (3) Guam, and (4) Inchon.

You will be interested to learn that we have extended our contract with Kaiser in order that the contractor may keep the study up to date and also investigate additional possible applications of nuclear power at remote military installations, including those falling below the 5 to 40 megawatts electric range of the original study. On February 16, 1960, in view of sharpening interest in antarctic applications, we directed that Kaiser study the Pole and Byrd Stations in essentially the same fashion as the 10 applications in the original study. The expected completion date for these additional reports is May 1, 1960.

By separate transmittal, we are forwarding copies of the complete report prepared by the contractor. We will be pleased to provide any additional information which you may require.

Sincerely yours,

JOHN A. MCCONE, *Chairman.*

COST ANALYSIS AND SUMMARY DATA - Remote Military Power Applications Study

	Okinawa	Guam	Thule AFB	NORAD	Azores	SUPER SAGE	NIKE-ZEUS	Inchon	Atl. Barge	McMurdo Sd.
I. SUMMARY DATA - NUCLEAR										
A. Power Requirement	40 MWe	20 MWe	25 MWe/ heat	7 MWe	5 MWe	5 MWe	10 MWe	10 MWe	20 MWe	5 MWe
B. Total Yearly Power	290x10^6 kwhr	145x10^6 kwhr	178x10^6 kwhr	32.6x10^6 kwhr	43.8x10^6 kwhr	26x10^6 kwhr	87.6x10^6 kwhr	70x10^6 kwhr	149x10^6 kwhr	26.3x10^6 kwhr
C. Plant Operating Factor	80%	80%	80%	100% of ave.	100% of firm	100% of firm	100% of firm	80%	85%	100% of firm
D. Reactor Size	150 MWt	75 MWt	130 MWt	28 MWt	28 MWt	28 MWt	28 MWt	40 MWt	83 MWt	11.4 MWt
E. Reactor Type	BWR	BWR	BWR	PWR (SM-2)	PWR (SM-2)	PWR (SM-2)	PWR (SM-2)	PWR	PWR	PWR (PM-2) (uncontained)
F. Fuel Enrichment	1.9%	3.4%	2.2%	90+%	90+%	90+%	90+%	4%	3.63MBA.55%	90+%
G. No. of Reactors	1	1	1	2	1	1	2	1	1	3
H. Rated Capacity of Plant	41.4 MWe	20.7 MWe	25.4 MWe	10.8 MWe	5.4 MWe	5.4 MWe	10.8 MWe	10.0 MWe	20.0 MWe	4.6 MWe
I. Net Firm Power	20.7 MWe	-0-	15.0 MWe	6.0 MWe ave.	5.0 MWe	3.2 MWe	10.0 MWe	-0-	10.0 MWe	3.0 MWe
J. Type of Installation	Land	Platform Barge	C3 Hull	Underground	Land	Underground	Land	ES2-8-C1 Hull	C3 Hull	Land
K. Location	Kin	Tumon Bay	Barge Basin	Camp Carson	Trest "E"	(Classified)	(Classified)	In. Harbor	Atl. Area	NAF
L. Nuclear Pay-out Time for DOD	12.1 yrs	19.1 yrs	5.1 yrs	-	-	-	(219 yrs)	-	(32 yrs)	4.9 yrs
M. Nuclear Savings (or excess cost) over 20-year Plant Life	$ 8,488,000	$ 430,000	$31,838,000	($12,076,000)	($ 7,435,000)	($7,407,000)	($5,766,000)	($ 7,325,000)	($5,104,000)	$21,580,000
II. SUMMARY DATA - CONVENTIONAL										
A. Rated Capacity of Plant	41.4 MWe	20.7 MWe	25.4 MWe	9.0 MWe	7.5 MWe	4.8 MWe	15.0 MWe	12.5 MWe	20.0 MWe	4.8 MWe
B. Net Firm Power	20.7 MWe	-0-	15.0 MWe	4.0 MWe(6.0 MWe ave.	5.0 MWe	3.2 MWe	10.0 MWe	7.5 MWe	10.0 MWe	3.0 MWe
C. Type of System	Steam Turbine	Steam Turbine	Steam Turbine	Diesel Engine	Diesel Engine	Diesel Engine	Diesel Engine	Diesel Engine	Steam Turbine	Diesel-Engine
D. Fuel Cost Per Gallon	$0.104	$0.108	$0.144	$0.156	$0.130	$0.196	$0.209	$0.104	$0.096	$1.06
III. NUCLEAR PLANTS										
A. Kaiser Estimates:										
1. Total Project Cost* (incl. Gov't Costs)	$24,020,000	$17,380,000	$22,860,000	$11,900,000	$ 6,110,000	$ 9,270,000	$11,800,000	$11,700,000	$20,970,000	$ 9,640,000
2. Annual DOD Budgeted Costs	$ 1,566,000	$ 1,092,000	$ 1,702,000	$ 910,000	$ 725,000	$ 521,000	$ 1,285,000	$ 808,000	$ 1,114,000	$ 772,000
3. Cost of Power **	9.5 mills	13.5 mills	16.0 mills	28.6 mills	23.5 mills	35.2 mills	21.4 mills	19.9 mills	14.5 mills	47.7 mills
B. Revised Estimates:										
1. Total Project Cost* (incl. Gov't Costs)	$23,702,000	$17,305,000	$22,622,000	$11,746,000	$ 6,121,000	$ 9,106,000	$11,836,000	$11,565,000	$20,994,000	$11,340,000
2. Annual DOD Budgeted Costs	$ 1,566,000	$ 1,092,000	$ 1,702,000	$ 1,081,000	$ 881,000	$ 629,300	$ 1,550,000	$ 778,000	$ 1,225,000	$ 917,000
3. Cost of Power **	9.5 mills	13.5 mills	15.9 mills	31.7 mills	27.1 mills	38.7 mills	24.4 mills	19.5 mills	15.3 mills	56.6 mills
C. Design Engineering Costs	$ 1,700,000	$ 900,000	$ 1,200,000	$ 700,000	$ 250,000	$ 530,000	$ 400,000	$ 600,000	$ 960,000	$ 470,000
IV. CONVENTIONAL PLANTS										
A. Kaiser Estimates:										
1. Total Project Cost *** (incl. Gov't Costs)	$10,770,000	$ 8,235,000	$11,720,000	$ 5,070,000	$ 3,075,000	$ 4,120,000	$ 5,490,000	$ 4,960,000	$ 7,390,000	$ 4,420,000
2. Annual DOD Budgeted Costs	$ 2,637,000	$ 1,567,000	$ 3,839,000	$ 811,000	$ 675,000	$ 471,000	$ 1,579,000	$ 756,000	$ 1,621,000	$ 2,342,000
3. Cost of Power **	10.9 mills	13.6 mills	24.8 mills	20.2 mills	18.9 mills	24.0 mills	21.2 mills	14.4 mills	13.6 mills	97.5 mills
B. Revised Estimates:										
1. Total Project Cost *** (incl. Gov't Costs)	$10,770,000	$ 8,235,000	$11,720,000	$ 5,070,000	$ 3,086,000	$ 4,865,000	$ 5,490,000	$ 4,960,000	$ 7,390,000	$ 4,420,000
2. Annual DOD Budgeted Costs	$ 2,637,000	$ 1,567,000	$ 3,839,000	$ 811,000	661,000	$ 471,000	$ 1,579,000	742,000	$ 1,650,000	$ 2,342,000
3. Cost of Power **	10.9 mills	13.6 mills	24.8 mills	20.2 mills	18.6 mills	29.5 mills	21.2 mills	14.1 mills	13.5 mills	97.5 mills

* Includes contingency at 12% and government costs at 6%.
** Includes 5% depreciation per year plus annual DOD budgeted cost.
*** Includes contingency at 0% and government costs at 6%.

Note: the costs and unit costs per kilowatt hour do not reflect interest on investment and fuel use charges, and therefore do not represent total costs to the Government. Furthermore, because they do not include cost of land, taxes, indemnity insurance, and return on investment, these figures should not be compared to commercial costs.

The total project costs include design engineering, direct construction costs (including test operation), indirect construction costs, escalation at 2 percent per year, Government costs (6 percent of the total less contingency), and contingencies of 12 percent for nuclear, and 8 percent for conventional, except in the case of McMurdo, with 15 percent there.

The total project cost does not include cost for land, taxes, interest on investment and nuclear indemnity insurance during construction.

The annual Department of Defense budgeted cost includes operating and maintenance costs (to include labor, spares, escalation), nuclear fuel costs (fabrication, burnup, reprocessing), and fuel oil costs (average commercial price escalated over 20 years).

The annual Department of Defense budgeted cost does not include fuel use charge, taxes, interest on investment, insurance, or profit. The cost of power to the Department of Defense in each case will be based on the sum of the annual Department of Defense budgeted cost, plus 5 percent depreciation of the initial cost per year. (See p. 361.)

You have had distributed to you, sir, copies of these slides which I am about to show.

The next slide, please, showing the distribution of the 10 sites that have been studied to date.

These were submitted in the report as of the 1st of April. Starting from left to right, Inchon, Korea; Okinawa; Guam. In the United States, super-Sage, Norad and Nike-Zeus; the Atlantic barge; Thule, Greenland; Asmara, Eritrea, and to the south, McMurdo Sound.

The next chart shows the summary of the power requirements for each of the 10 sites. These were requirements given to the Atomic Energy Commission by the Department of Defense.

SUMMARY OF DATA

	POWER REQUIREMENT	YEAR REQUIRED	AVE. FUEL OIL COST - ($/GAL)	TYPE NUCLEAR PLANT SELECTED	TYPE CONVENTIONAL PLANT SELECTED
OKINAWA	40 MWe, 40 MWe	1963, 1965	0.104	BWR 41.4 MWe	Steam-Turbine
GUAM	20 MWe	1963	0.108	BWR 20.7 MWe	Steam-Turbine
THULE	25 MWe + HEAT	1963	0.144	BWR 25.4 MWe	Steam-Turbine
NORAD	7 MWe	1963	0.156	PWR 10.8 MWe	Diesel Engine
ASMARA	5 MWe	1963	0.130	PWR 5.4 MWe	Diesel Engine
SUPER SAGE	5 MWe	1963	0.156	PWR 5.4 MWe	Diesel Engine
NIKE-ZEUS	10 MWe	—	0.209	PWR 10.8 MWe	Diesel Engine
INCHON	10 MWe	1963	0.104	PWR 10.0 MWe	Diesel Engine
ATLANTIC BARGE	20 MWe	1963	0.096	PWR 20.0 MWe	Steam-Turbine
McMURDO SOUND	5 MWe, 1 MWe	1963, 1964	1.06	PWR 4.6 MWe	Diesel Engine

Okinawa, 40 megawatts electrical by 1963, an additional 40 megawatts electrical by 1965. Average cost of fuel oil, $0.104 per gallon. These oil prices are escalated over the next 20 years.

Representative HOLIFIELD. What does that mean, $0.104?

Colonel WILLIAMS. Approximately 10 cents a gallon, sir. The type nuclear plant selected by the contractor for this study, a boiling-water reactor, 41.4 megawatts electrical. In this case a comparison is made between the nuclear plant and a comparable steam turbine conventional plant.

Guam, 20 megawatts electrical by 1963. $0.108 per gallon for oil. A boiling-water reactor, this one, 20.7 megawatts, and a steam turbine as our conventional plant to compare it with.

Thule, 25 megawatts electrical, plus considerable amounts of heat by 1963. $0.144 is the price per gallon of oil. Boiling-water reactor was chosen again, with the steam turbine as the conventional plant.

Next follow four plants of smaller sizes, first Norad, 7 megawatts electrical by 1963, $0.156 the price of oil. Here a pressurized water reactor of 10.8 megawatts electrical is compared to a diesel engine.

Asmara, 5 megawatts electrical by 1963, $0.130 for the oil. Pressurized water reactor, 5.4 megawatts electrical, as compared to diesel engine again.

Super-Sage, 5 megawatts, essentially the same as the line above, with a cost of oil of $0.156 per gallon.

Nike-Zeus, 10 megawatts electrical, date unspecified, $0.209 per-gallon for the oil; pressurized water compared with the diesel engine.

Representative HOSMER. What runs the oil cost so high here?

Colonel WILLIAMS. This is northern United States or southern Canada, where there is considerable land transportation involved.

Dr. WILSON. Diesel fuel, whereas several of the others are ordinary fuel oil.

Colonel WILLIAMS. That is correct, sir. In the case of Inchon—this is a 10-megawatt electrical barge-mounted plant, required by 1963 which the Army is interested in with initial use at Inchon—$0.104 is the price of oil. Pressurized water again compared to a diesel engine.

Atlantic barge, 20 megawatts electrical by 1963. Average cost of fuel, $0.096 per gallon. Pressurized water again, and compared this time to steam turbine. The steam turbine was used in case of conventional powerplants over 12,000 kilowatts. Below this, the nuclear plants were compared with diesel engines.

Representative VAN ZANDT. Is this Atlantic barge similar to the barge scheduled for Inchon?

Colonel WILLIAMS. The same idea, with twice the power, a strategic reserve power source.

Finally, the McMurdo site, 5 megawatts electrical by 1963 and an additional megawatt by 1964—$1.06 per gallon for oil. Pressurized water again, and compared with a diesel engine.

The next chart shows the costs associated with these various situations. I should emphasize that they are not firm bid-type costs. They are the best information that Kaiser Engineers could obtain. I have a letter from Kaiser Engineers to me dated March 8, 1960, which says that these figures represent a fair estimate of what should be expected as a fixed-price bid.

SUMMARY OF COSTS

	TOTAL PROJECT COST ($ Thousands)		ANNUAL DOD BUDGET COST ($ Thousands)		COST OF POWER (Mills/kwhr)		NUCLEAR SAVINGS OR EXCESS COSTS (Nuclear Payout Time)
	Nuclear	Conv.	Nuclear	Conv.	Nuclear	Conv.	
OKINAWA	23,702	10,770	1,566	2,637	9.5	10.9	8,488 (12.1 yrs)
GUAM	17,305	8,235	1,092	1,567	13.5	13.6	430 (19.1 yrs)
THULE	22,622	11,720	1,702	3,839	15.9	24.8	31,838 (5.1 yrs)
NORAD	11,746	5,070	1,081	811	31.7	20.2	(12,076)
ASMARA	6,121	3,086	881	661	27.1	18.6	(7,435)
SUPER SAGE	9,106	4,865	629	471	38.7	25.5	(7,407)
NIKE-ZEUS	11,836	5,490	1,550	1,579	24.4	21.2	(5,766)
INCHON	11,565	4,960	778	742	19.4	14.1	(7,325)
ATLANTIC BARGE	20,994	7,390	1,225	1,650	15.3	13.5	(5,104)
McMURDO SOUND	11,340	4,420	917	2,342	56.4	97.5	21,580 (4.9 yrs)

With the above in mind, assuming the vendor and subcontractor estimates, plant criteria, and site conditions remain essentially the same, "Kaiser Engineers would be willing to bid the construction work at firm prices approximately equal to the escalated construction costs shown in the report; or would be willing to undertake the per-

formance of the work on a turnkey basis at firm prices approximately equal to the total project costs shown in the reports."

The cost situation here, first, total project cost. Here again we are talking in Department of Defense terms. For the Okinawa, the nuclear plant, $23.7 million versus $10.77 million for the conventional.

Guam, $17.3 million versus $8.2 million, roughly.

Thule, $22.6 million versus $11.7 million.

Norad, $11.7 million versus $5 million.

Asmara, $6.1 million nuclear, $3 million conventional.

Super-SAGE, $9.1 million versus $4.8 million.

Nike-Zeus, $11.8 million versus $5.5 million.

Inchon, $11.6 million versus $4.9 million.

Atlantic barge, $20.99 million versus $7.4 million for the conventional.

McMurdo Sound, $11.3 million versus $4.4 million for the conventional.

The next column, annual Department of Defense budgeted costs. These are in millions of dollars. In the case of Okinawa, $1.566 million per year. For conventional, $2.637. Guam, $1.092 nuclear, versus $1.567 conventional. Thule, $1.7 for the nuclear, $3.839 for the conventional.

The next several sites I would like to skip because they do not show any hope of an economic justification. We must bear in mind, however, that for military use there are other factors than economics, but for the present we are looking at it on an economic basis.

The NORAD, Asmara, Super-SAGE, and Nike-Zeus have no particularly strong case, or no case at all, from an economics point of view. Inchon does not show up too well economically either, but the Army is interested in this particular plant because of its strategic reserve use.

Representative HOLIFIELD. This would be a barge that could be towed to different locations?

Colonel WILLIAMS. That is correct, sir. The Atlantic barge, nuclear $1.22 million per year, $1.65 million for the conventional. The McMurdo Sound, $.917 million per year versus $2.342 million for the conventional. These will be diesel plants in this case.

The next column, cost of power. In the case of Okinawa—bear in mind that we are including the annual Department of Defense budgeted cost plus 5 percent of the total project cost in computing these figures in mills per kilowatt-hour—the figures come out very close, 9.5 mills for the nuclear, 10.9 mills for the conventional.

Let us break out the next column, too, with a crossover point, that is, nuclear breaking even, cumulative costwise, with conventional in 12.1 years, and a savings over the 20-year period of $8.488 million with nuclear.

In the case of Guam it is even closer. The cost of power for the nuclear, 13.5 mills, for the conventional, 13.6. In this case we show a break-even point or crossover point of 19.1 years. This is strictly marginal.

Representative HOLIFIELD. What do you mean by "crossover"?

Colonel WILLIAMS. If one adds the initial cost, the total project cost, and then adds the annual Department of Defense budgeted cost

for a certain number of years, and does this for conventional and for the nuclear, at some point these sums become equal. The cumulative cost of the nuclear becomes equal to the conventional.

Representative HOLIFIELD. After that you move into a profit from the nuclear?

Colonel WILLIAMS. After that one gains by going the nuclear route.

Representative HOLIFIELD. What depreciation life are you using and are you using the same on both nuclear and conventional?

Colonel WILLIAMS. We are using 5 percent straight depreciation.

Representative HOLIFIELD. Twenty years?

Colonel WILLIAMS. Twenty years on both.

Representative HOLIFIELD. Maybe I did not make myself clear. That is your depreciation rate, but what about the life of your plant? Is there any difference in the life of your plant? I am talking about the actual life, not the writeoff life.

Colonel WILLIAMS. These designs are based on 20 years, sir.

Representative HOLIFIELD. Would you express an opinion or can you at this time, whether the nuclear plant would outlast the conventional plant? We know that conventional plants have frequently 40- or 50-year lives. So while this is a bookkeeping life, I am talking about a usable life.

Colonel WILLIAMS. We understand, sir, that the life of diesel plants down in the Antarctic is much shorter than this. In this case I think 20 years would be really optimistic as far as the conventional plant is concerned. I would believe that the nuclear plant, being more carefully built, would have somewhat longer life than the diesel. Dr. Mooney said that in the Antarctic, for diesel plants, the life is 3 or 4 years.

Representative HOLIFIELD. Three to four years of useful life?

Colonel WILLIAMS. Yes, sir.

Representative HOLIFIELD. Then it has to be replaced or practically rebuilt.

Colonel WILLIAMS. It has to be replaced, sir. This is the procedure they are using.

Representative HOLIFIELD. Is this taken into consideration in your computations? In other words, in 20 years you would have a replacement five times, a duplication of capital investment five times, and it would run your conventional costs up much higher, assuming that your nuclear plant would last 20 years.

Colonel WILLIAMS. These replacements are built into the cost for the Antarctic.

Representative PRICE. What about the nuclear for the Antarctic?

Colonel WILLIAMS. This is on the basis of 20 years.

Representative WESTLAND. The question I would like to ask is: Are you treating both the nuclear plant and the conventional plant in the same manner? Let us take Okinawa, for example.

You say that a nuclear plant would cost $23,702,000 and the conventional plant would cost $10,770,000. My question is, Does that represent the total cost to the Government in both cases?

Colonel WILLIAMS. It does; yes, sir.

Representative WESTLAND. I have been given to understand that it does not. For example, you do not take interest charges on the money. You do not put in fuel costs. Perhaps there might not be

any taxes or insurance or things of that kind. What I want to know is, Are you treating them both the same?

Colonel WILLIAMS. May I correct that? It includes the total cost to the Department of Defense. It does not include the Government cost of the 4 percent on the debt or the fuel use charge.

Representative WESTLAND. Let us take the taxpayer. Is it the total cost to the taxpayer?

Colonel WILLIAMS. No, sir.

Representative WESTLAND. Is it the total cost in one case and not in the other? I mean, if there is going to be a comparison, we ought to have them both on the same basis.

Colonel WILLIAMS. The use charge would apply only to the nuclear plant.

Representative WESTLAND. That is right.

Colonel WILLIAMS. The 4 percent or whatever the Government is paying for the initial fund, that is included in each case.

Representative HOSMER. Would the judge ask about the R. & D. costs?

Representative WESTLAND. Go ahead; you ask them.

Representative HOSMER. Are those included in the R. & D. costs as overhead?

Colonel WILLIAMS. No, sir. These are the costs that we would expect to get from the industry for a specific contract based on a fixed price.

Representative PRICE. On the type of reactor planned at Okinawa, the R. & D. has been taken care of in many other projects.

Colonel WILLIAMS. Yes, sir.

Mr. FLOBERG. I would like to answer both your statement and Mr. Hosmer's question by saying that the Commission, although it has not taken any formal action on any proposal because there has not been any is unanimously of the mind that if one of these plants is to be constructed, it must be done on a fixed price, fixed date of delivery, clear and definitive guarantee basis with appropriate penalties in it for nonperformance.

In other words, the attitude of the Commission toward any plant located in a remote site is not that it is a developmental plant. No research and development is to go into it. It is a demonstration plant of an established technology in a different and a difficult environment.

While I have this convention of nuclear peddlers behind me here, I would like to make it clear that our attitude is pretty inflexible on this. We expect firm performance here and no baloney and no cost-plus-fixed-fee or anything of that sort.

Representative VAN ZANDT. In other words, you are going into the nuclear power business at remote sites.

Mr. FLOBERG. This is a demonstration, as I say, in a different and difficult environment with nothing original to be tested here.

Representative HOLIFIELD. In your opinion, the art has proceeded to the point where the manufacturers can meet that requirement.

Mr. FLOBERG. Reliability is to be the essential feature of this demonstration. If we cannot get the kind of reliability I am talking about, with appropriate penalties for nonperformance, as far as the Commission is concerned, we do not see any real advantage of undertaking such a project.

Representative PRICE. In other words, these types of plants we are talking about in the locations we are talking about are not being built for experimental purposes.

Mr. FLOBERG. That is correct.

Representative WESTLAND. For example, let us go to Guam here. You have $17 million. If you take 5 percent of that, what is that—$850,000? You say the annual cost is $1,092,000. You mean to say you are going to run that plant with all charges for $150,000 for a year?

Dr. WILSON. We do not know what the firm bids are going to be.

Representative WESTLAND. It would seem pretty obvious to me you have not set up depreciation charges in that figure.

Dr. WILSON. Depreciation charges on the assumption of a 20-year life which may be somewhat of a gamble. If a diesel engine only lasts 5 years, I cannot conceive of a first-design reactor lasting 20 years. It does not seem reasonable that it would be that much better, especially in the first installation that would be made.

Also, with regard to your question on an interest charge, I thought the table that you showed, Colonel Williams, showed that interest was not included.

Colonel WILLIAMS. That is right.

Dr. WILSON. Including interest would penalize the nuclear plant in comparison with the conventional. That would wipe out any slight advantage that it has at Guam and Okinawa. On the other hand, it would not wipe out the apparent advantage of nuclear plants for Thule and McMurdo Sound, which seem to be pretty substantial.

Representative WESTLAND. I can understand that quite well. However, I would like to ask somebody, in that annual cost for a plant at Guam, have you taken a 5-percent depreciation on $17 million?

Colonel WILLIAMS. Yes, sir. Could I give you an example on the Okinawa situation?

Representative WESTLAND. Yes.

Colonel WILLIAMS. Total project cost, $23.7 million. One-twentieth of that is $1.185 million. We add to that the annual Department of Defense budgeted costs of $1.566 million. These are operating costs that the Department of Defense budgets for labor, maintenance, and spares.

Representative WESTLAND. This $1.566 million is added to the 5 percent?

Colonel WILLIAMS. Yes, sir.

Representative WESTLAND. If you are in business, that depreciation becomes a charge, does it not?

Colonel WILLIAMS. It does; yes, sir.

Representative WESTLAND. If you took depreciation, you would come up with $2,750,000 as an annual cost on Okinawa.

Colonel WILLIAMS. That is right, sir. But our basis was for Department of Defense costs. These are the figures that the Army, Navy, and Air Force would have to budget.

Representative WESTLAND. I understand, but in theory, at the end of 20 years you have nothing left.

Representative PRICE. Will the gentleman try to make a definite comparison in the manner of handling finances of a conventional plant and this particular nuclear plant?

Representative WESTLAND. This is what I am trying to get at.

Representative HOLIFIELD. The comparison is a true comparison because you treat the depreciation the same on the conventional plant as the other one.

Representative PRICE. That is the question Mr. Westland was trying to get at. Is it a fact that you handle both in the identical fashion?

Dr. WILSON. The depreciation is in on both, but the interest is not.

Representative HOLIFIELD. It is not, but it would be comparatively the same as depreciation.

Dr. WILSON. Yes, it would but it is not added in these figures.

Representative HOLIFIELD. You do not add interest on the aircraft carrier or anything else for Department of Defense.

Dr. WILSON. I know. But Mr. Westland was asking about the taxpayer cost.

Representative HOSMER. This Okinawa plant that the gentleman from Washington is talking about would cost roughly $13 million more in capital costs. So at 4 percent there would be a little over half a million dollars interest a year as a cost to the Treasury, which is not factored into these costs.

Mr. FLOBERG. That is correct.

Representative HOLIFIELD. That is established Government policy. This is not any departure from Government policies.

Mr. FLOBERG. No. It is normal budgeting practice. Part of the fallacy of Government financing is not to count all the costs. If some other agency pays for them, one figures they come free. The taxpayer, of course, cannot figure that way.

Representative VAN ZANDT. Commissioner Floberg, a moment ago you talked about the reliability of these plants. Has the Commission taken a position as to whether or not they are reliable to the extent that we should move into a program of this nature?

Mr. FLOBERG. I think the Commission will be able to evaluate that when the problems, if any, are submitted and by the character of the guarantees that are incorporated in the proposals and the penalties that manufacturers are willing to assume if they fail to meet the guarantees. The answer to your question is, I believe such proposals could be submitted; yes, Mr. Van Zandt.

Representative VAN ZANDT. In other words, then, you think atomic power has developed to the extent it would be reliable if installed in these remote areas of the world?

Mr. FLOBERG. Yes, sir. I think it should be done on a put-up-or-shut-up basis and I think there are manufacturers who can put up.

Representative VAN ZANDT. Would this reliability somewhat follow the lines of EURATOM?

Mr. FLOBERG. Don't ask me that question.

Representative VAN ZANDT. I recall a discussion we had, especially with regard to the guarantee of fuel elements.

Mr. FLOBERG. EURATOM'S troubles do not have to do with the unreliability of the reactors in question. They have to do with the unreliability of other elements, Mr. Van Zandt.

Senator JACKSON. Mr. Chairman, may I ask a couple of questions? I do not know whether you covered these questions during my absence.

First I want to ask what the results were of the nuclear powerplant test last week in New York, if anyone is in a position to comment on that.

Representative HOLIFIELD. At a remote location?

Senator JACKSON. Yes, at a remote location. I assume that is what we are on. The one that goes in above Thule.

Mr. FLOBERG. Are you talking about the Alco plant?

Senator JACKSON. Yes.

Colonel WILLIAMS. That is being built for the Army by Alco Products, Inc. It is being assembled on the ground at Dunkirk, N.Y. The nonnuclear side of it is in test now. They are using an oil-fired boiler as the heat source. All other components other than the nuclear will be checked out there. This seems to be going along successfully, sir, and it will be taken apart and packaged and made available for shipment in May.

The next chart provides comparative data on McMurdo Sound, Byrd Station, and Pole Station.

	McMurdo Sound		Pole station	Byrd station
	Alternate 1	Alternate 2		
Summary data:				
Net firm power—Kilowatts electric	3,000	1,500	500	800
Nuclear plant—Number-type	3 PM–1	2 PM–1	1 PL–2	1 PL–2
Rated capacity—Kilowatt electric	3,000	1,500	1,000	1,000
Number-size (kilowatt electric) of backup units (diesel generators)	(1)	(1)	3/250	3/400
Reference conventional plant—Number-size (kilowatt electric) of units (diesel generators)	6/800	4/800	4/250	4/400
Nuclear costs:				
Total project cost	$11,340,000	$7,820,000	$8,337,000	$10,088,000
Annual DOD budgeted cost	$917,000	$613,000	$473,000	$626,000
Cost of power—Mills per kilowatt-hour	56.4	77	203	162
Conventional costs:				
Total project cost	$4,420,000	$3,400,000	$4,680,000	$7,534,000
Annual DOD budgeted cost	$2,342,000	$1,170,000	$1,676,000	$2,614,000
Cost of power—Mills per kilowatt-hour	97.5	101	436	427
Nuclear payout time (years)	4.9	7.9	3	1.3
Nuclear savings (over 20 years)	$21,580,000	$6,720,000	$20,403,000	$37,206,000

[1] Nuclear.

Senator JACKSON. Is this the type of plant that could be used in the Antarctic stations?

Colonel WILLIAMS. Yes, sir.

Senator JACKSON. Mr. Chairman, in connection with the three areas in the Antarctic, namely, McMurdo Sound, Byrd and Pole Station, we referred to in the previous testimony, I wonder if the Commission could give us any estimate now as to how long it would take to move on those projects?

Colonel WILLIAMS. We feel, sir, that we could have——

Senator JACKSON. I am not asking you the policy question. We will defer that until Mr. McCone comes. I am merely interested now in getting the situation in the record here with reference to moving ahead on calling for the design and bidding and so on.

Mr. FLOBERG. Is that what you mean by move on? What day could we initially issue invitations for proposals?

Senator JACKSON. Yes. When could you call for proposals or bids?

Colonel WILLIAMS. If we had the green light all the way right quick, we could award the contract, I believe, by the 1st of July.

Senator JACKSON. The 1st of July?

Colonel WILLIAMS. Yes, sir; this year. To do that we would have to send out invitations about the 1st of May.

Senator JACKSON. In order to do that?

Colonel WILLIAMS. Yes, sir.

Sir, you might be interested in what happens to the dates at the other end. If we contract for a plant on the 1st of July, the lead-time on them, we believe, is about 14 months. It would be available on the 1st of September 1961. Then we would assemble the plant stateside and test it out, and then take it apart and prepare it for shipment and have it dockside by November 1, 1961, and then it could be transported.

Senator JACKSON. When you say "dockside," you mean ship it by air because you do not get into that area November 1 by ship?

Colonel WILLIAMS. Yes, sir. In the Antarctic you would.

Senator JACKSON. Are you going to fly it down?

Colonel WILLIAMS. These will be air transportable packages, sir. For cost purposes, however, we would probably use ships as far as McMurdo is concerned, anyway.

Senator JACKSON. I assume that you could get it in there by ship in December.

Colonel WILLIAMS. Yes, sir.

Senator JACKSON. Or the 1st of January.

General, did you want to comment on that?

General LUEDECKE. As of right now, I see no reason why it could not be shipped by air if this was indicated at the time.

Senator JACKSON. What you are saying here is, if there is a decision by the 1st of May and you can get the invitations out by that time, you would have a plant available for shipment from the States by November 1, roughly.

Colonel WILLIAMS. Of 1961; yes, sir.

Senator JACKSON. Would this involve doing the necessary onsite work this fall?

Colonel WILLIAMS. Some of this would have to be started, sir. At least the foundation materials.

Senator JACKSON. What is your best estimate as to when it would become operational under these circumstances?

Colonel WILLIAMS. On this schedule, sir, by March 1962.

Senator JACKSON. I want to say, Mr. Chairman, I think that is a pretty fine record, assuming that the Commission is given the necessary authority. I do believe that at these three sites, arguments of economic feasibility and so on, are really answered.

As I mentioned in hearings previously, the logistic problem in the Antarctic is enormous. I believe 80 percent of all of the logistic support which the Navy has responsibility for in the Antarctic involves fuel oil for power and for heat. The staff, at my request, checked with the appropriate people and they have given me this information, Mr. Chairman, in connection with the difficult logistic problem we have in the Antarctic.

Representative HOLIFIELD. This was requested in public session from the admiral who was testifying.

Senator JACKSON. That is right. I understand this comes from the Navy.

Representative HOLIFIELD. That is right.

Senator JACKSON. I asked for the number of lives that had been lost and they supplied this information: Between 1956 and 1959, for 3 years, 17 lives, 18 aircraft at a value of $10.3 million, and 13 vehicles at $400,000.

The total material loss is $10,700,000. I cannot think of an area of the world where better use could be made at this time of nuclear-powered reactors. In addition, needless to say, in view of the position that our Government has taken in signing the treaty for the peaceful development of the Antarctic continent, I think you have here all the necessary arguments that the State Department would like to use for the diplomatic needs of this country.

That is all I have, Mr. Chairman.

Representative HOSMER. May I ask one question about the McMurdo oil costs? Does that all go in there in drums?

Colonel WILLIAMS. No, sir. To McMurdo this would go in bulk in tankers.

Representative HOSMER. It would still cost you that price?

Colonel WILLIAMS. Yes, sir.

Representative HOSMER. Do you have an additional length of route? What accounts for that big price?

Colonel WILLIAMS. This includes the whole logistical tail that supports this operation, including one or two icebreakers that have to break their way in each year and keep the channels open.

Representative HOSMER. I see.

Senator JACKSON. Mr. Chairman, there is one other thing.

Representative HOLIFIELD. At the conclusion of your previous remarks, let us put the prepared material in regard to this memorandum which was furnished us so that the record will be clear on this loss of equipment and loss of life.

(The material referred to will be found on p. 221.)

Senator JACKSON. Mr. Chairman, I had just this one other question. This is a practical question.

I think it is quite clear that there will not be final action, probably, on the authorization bill by May 1, that is, with the Presidential signature. I want to ask the AEC if it would be possible to go ahead with a plan calling for bids or proposals by May 1 prior to the actual completion of the authorization bill, assuming that it is in the bill and is moving through Congress, with a stipulation in the call for proposals or bids that it is subject to the authorization and the appropriation of funds by the Congress.

Mr. FLOBERG. I do not remember ever proceeding with a proposal without authorization. That depends on what the Congress is going to do. I do not know anything illegal in connection with it.

Mr. RAMEY. I think in the case of facilities in Idaho the Commission has done this several times.

Mr. FLOBERG. Have we?

Mr. RAMEY. Of getting proposals on facilities there subject to obtaining authorization by Congress.

Senator JACKSON. I would think legally it should not be too much of a problem.

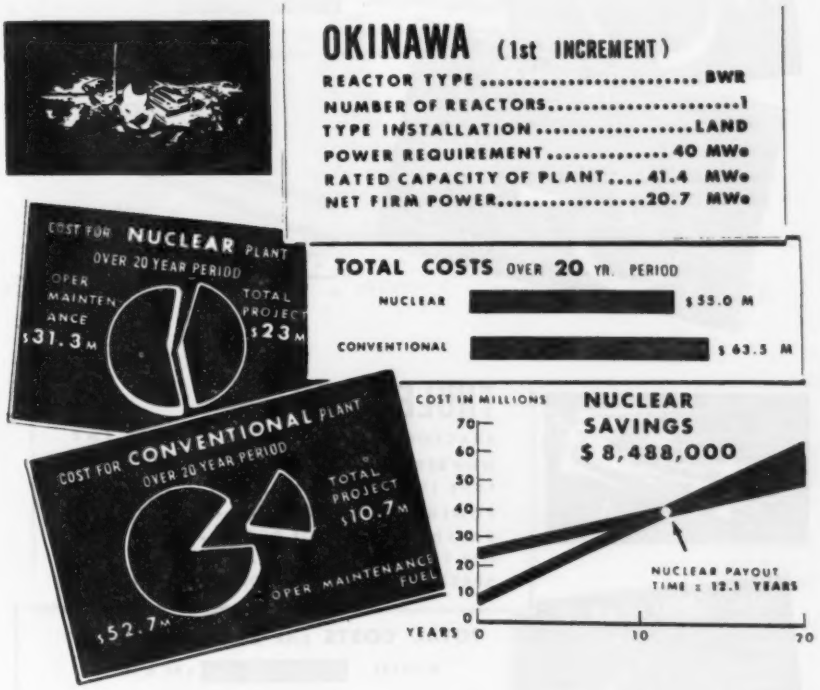
Mr. FLOBERG. I know of no legal problem.

Senator JACKSON. You could stipulate in your proposal that it is subject to that contingency.

Mr. FLOBERG. We would have to have the concurrence of the executive branch in so doing because we are doing this as an agent for them.

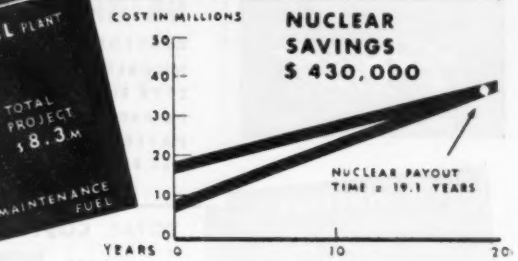
Representative HOLIFIELD. All the charts furnished to us, which will be put in the record, show that the McMurdo Sound operation would amortize itself in 4.9 years. When we consider the fact that aircraft loss and our equipment loss is $10.7 million for 3 years operation and the total project cost of the McMurdo Sound station would be $4,420,000, and the other remote sites a comparative amount, it would seem to indicate that the saving in aircraft loss and rolling stock in 3 years' time would almost pay for these installations.

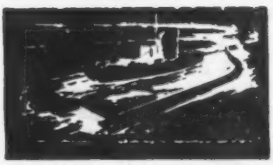
(The charts referred to follow:)



GUAM

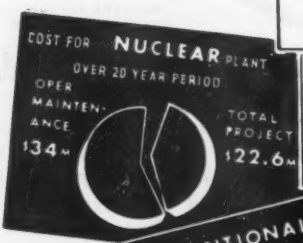
REACTOR TYPE.....BWR
NUMBER OF REACTORS.....1
TYPE INSTALLATION.....PLATFORM BARGE
POWER REQUIREMENT.....20 MWe
RATED CAPACITY OF PLANT....20.7 MWe
NET FIRM POWER..... -0- MWe

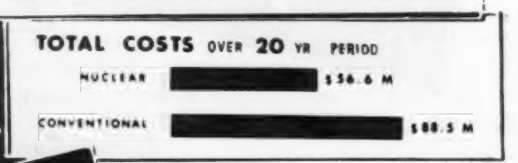


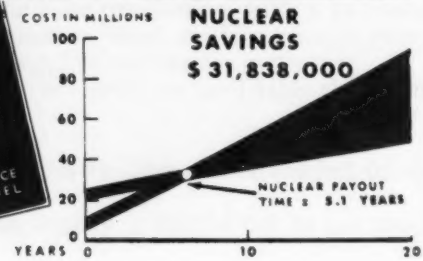


THULE AFB

REACTOR TYPE.....BWR
NUMBER OF REACTORS.....1
TYPE INSTALLATION.....C3 HULL
POWER REQUIREMENT.....25 MWe + Heat
RATED CAPACITY OF PLANT.....25.4 MWe
NET FIRM POWER.....15.0 MWe
SPACE HEAT.....150,000,000 BTU/hr.

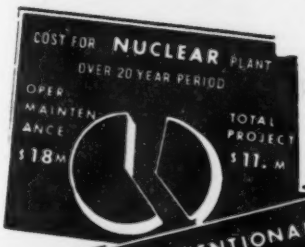


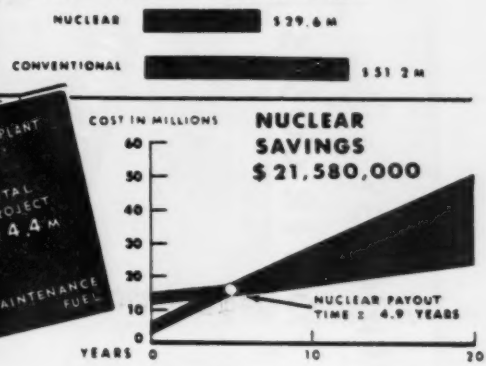


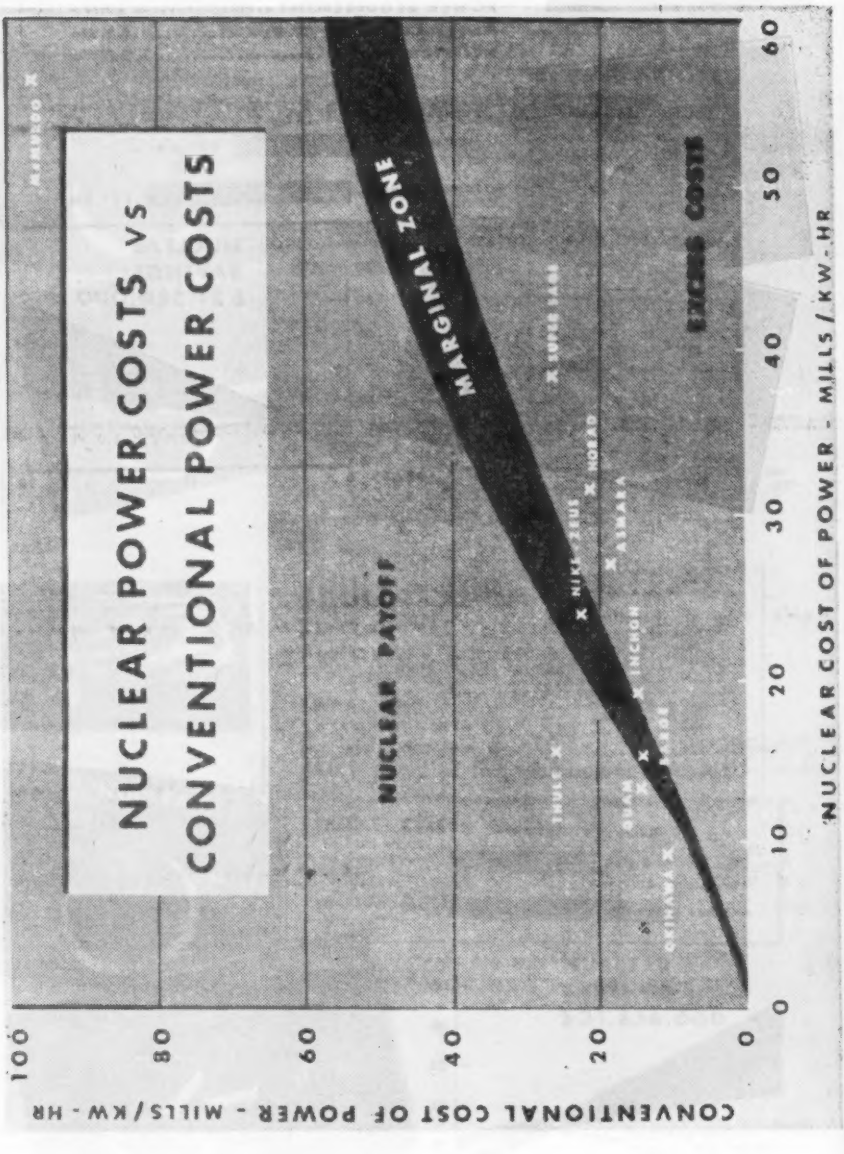


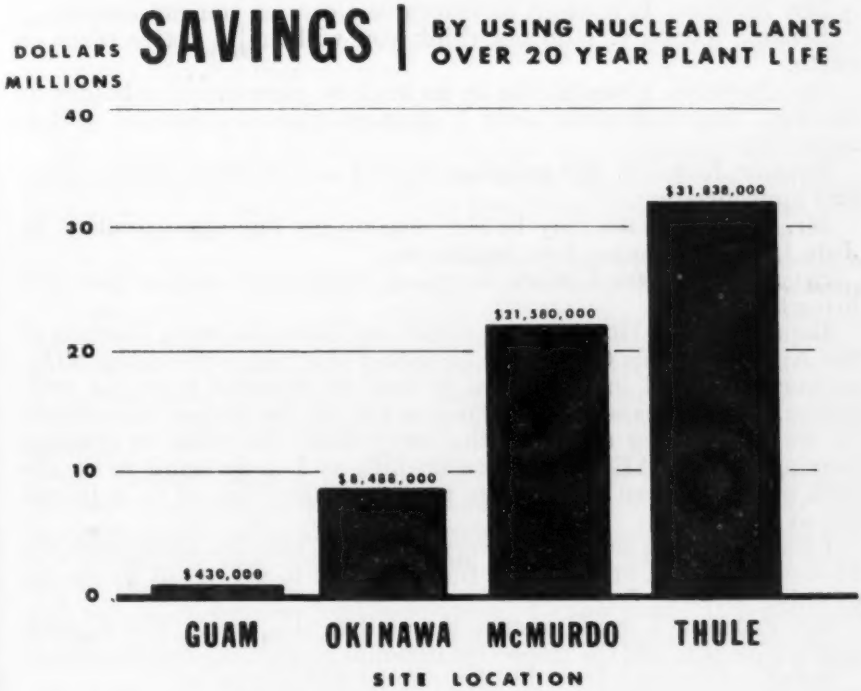
McMURDO SOUND

REACTOR TYPE ..... PWR (PM-1)
NUMBER OF REACTORS 3
TYPE INSTALLATION ..... LAND
POWER REQUIREMENT ..... 5 MWe
RATED CAPACITY OF PLANT ..... 4.6 MWe
NET FIRM POWER ..... 3.0 MWe






NUCLEAR POWER COSTS VS
CONVENTIONAL POWER COSTS
NUCLEAR PAYOFF
MARGINAL ZONE
EXCESS COSTS
CONVENTIONAL COST OF POWER - MILLS/KW-HR
NUCLEAR COST OF POWER - MILLS/KW-HR
0
20
40
60
80
100
0
10
20
30
40
50
60



This is not mentioning the fact that we have lost 17 lives in transporting fuel oil in, or at least in transportation between these bases and the Zone of Interior, and at least 80 percent of that transportation is involved in the transportation of fuel oil.

So it looks like it might pay itself out very easily at the McMurdo Sound, pole and Byrd sites.

Senator JACKSON. Now, Mr. Chairman, if I might just supplement your remarks, I would point out that at the Byrd station it will pay out in 1.3 years, and at the pole station in 3 years; is that correct?

Colonel WILLIAMS. Yes, sir. This is data which has been developed by my staff on preliminary figures from the Kaiser people. The Kaiser report on the Pole and Byrd are not in yet. We gave Kaiser these as an additional task in February.

Senator JACKSON. This is an estimate?

Colonel WILLIAMS. This is our best estimate at this time.

Senator JACKSON. Even if you double it, if you are off by 100 or 200 percent, it is clear that the economic feasibility of nuclear power at the three stations is pretty well documented.

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NUCLEAR COST OF POWER - MILLS / KW-HR

Mr. FLOBERG. It is about as favorable a case as you can develop.

Senator JACKSON. I do not think you will find a better place on earth.

Mr. FLOBERG. I would like to go back to your question before on timing. Any talk about July 1 assumes appropriations as well as authority.

Senator JACKSON. My question coupled and included authorization and appropriation.

Mr. FLOBERG. This may be the year we get our appropriation by July 1, but this has not been traditional.

Senator JACKSON. I think there are compelling reasons that will bring that about.

Representative HOLIFIELD. I might say that Chairman Cannon of the Appropriations Committee has asked this committee to have this authorization bill in his hands, at least as reported from the committee, whether passed on the floor or not, by the 18th of this month. So we are pushing ahead on that very fast. He plans on starting hearings on the AEC authorization bill, as I undertsand it, on the 19th of April, even before it is passed on the floor, if it is passed out of committee.

I know that his schedule is very tight and that he, along with the House leadership, are going to try very hard to get us out by the 1st of July.

Mr. FLOBERG. I would assume it would be this year. The possible alternative is to ask the respective national committees for the money.

Senator JACKSON. I would like to finish this one point.

Mr. Chairman, the only reason I am mentioning the date of May 1 is to save a whole year; because of the problem of moving in the Antarctic at times other than in the fall. In view of this fact and the need for the proposals on time, I would just hope that we could do it that way.

I think it should appeal to the Bureau of the Budget in saving some money. Here is a classic case where you get one situation when you are dealing with a capital budget, and you get something else when you are dealing with an operating budget.

The failure to consider the two together and to get the real savings results in the kind of situation we have had for some time. I raise the question only in the interest of trying to save a whole year's operating cost, which means quite a bit when you look at the operational expenses in connection with the maintenance of the three stations in Antarctica.

Mr. FLOBERG. I think it has been traditional to be shortsighted about the relationship of capital costs with operating costs. I have been keeping track of Federal budgets for 10 years.

Senator JACKSON. It has been going on ever since the budget was set up back in 1922.

Representative HOLIFIELD. Let us take the McMurdo Sound station. The annual budget for nuclear would be $917,000, and the annual budget for conventional would be $2,342,000. When you talk to the respective Defense Department agencies, they are much more interested in that annual budget item of $917,000.

It would seem to me that they should be interested in the saving that could be made on a total time basis. When they have to put an

additional capital investment above the conventional capital investment, that is where we run into trouble because they naturally have so many places for their dollars.

This brings to my mind the question whether this could be done on any kind of a joint financing basis.

Mr. FLOBERG. The Bureau of the Budget has indicated, Mr. Chairman, as you are well aware, that the using service, or the customer, should finance these projects. That does bring them face to face with the problem you have described.

One of the things that I have wondered about, Mr. Chairman, is why the manufacturers do not come up with some kind of leasing arrangement which would, over a period of time, attrit the capital cost. I should think this would be attractive to them and the military services, too. I have never heard anybody suggest that.

Representative HOLIFIELD. If they can sell an automobile on a 36-month contract, they might be able to sell this on a 60-month contract.

Mr. FLOBERG. It is a little bit like that. It is more analogous to the lease-purchase system. Some kind of system whereby the services which do have to face this annual expenditure basis for capital items in competition with this capital item would not have such a difficult decision to make.

It is a hard decision for the services. I know that. It is the same reason that people put off buying a new car even though it might be cheaper than their old one to operate. They keep the old one a year longer because they do not want to lay out the capital cost of a new car.

Representative HOSMER. The record is a little unclear as to the personnel and material casualities; whether they were incurred in the McMurdo delivery or the delivery from McMurdo to Byrd and South Pole.

When you submit those figures, I would hope they would be indicative on this point so that we are not in an apple and orange situation.

Representative HOLIFIELD. Dr. Mooney, could you respond to that question, or are you the proper person to ask?

Dr. MOONEY. The lives are lost in the total program in setting up the backup logistic support. It was not necessarily delivery of barrels to South Pole or Byrd Station. It was in the total program that these lives were lost, making possible at time the availability of facilities to transport.

One of the losses in the aircraft, the C–124, was the loss of the aircraft that came in to take personnel and the aircraft for the South Pole and Byrd Station flights. That was washed out and those men's lives were lost.

Representative HOSMER. You cannot tie it down to this particular factor. You have to have planes and personnel going in and out of there anyway. What diminution there is on account of this reason would be the differential.

Dr. MOONEY. Actually the C–124's were brought in for a specific freight job or to carry cargo. They were not brought in to bring passengers or personnel.

Representative HOSMER. They were bringing in the oil drums for transshipment to McMurdo.

Dr. MOONEY. Those planes that were lost were on their way to do that. They were landing at McMurdo Sound to fulfill missions at the Pole and Byrd Station. So the loss is integrated.

Representative HOSMER. As a consequence, from that standpoint your nuclear station, either at Byrd or South Pole, would have an influence on the casualty factor rather than the nuclear station at McMurdo.

Dr. MOONEY. Otherwise it would not have been necessary to have the C–124's because they dropped the supplies from the air.

Representative HOLIFIELD. So there would be a proportionate reduction in relation to the number of trips necessary from the Zone of the Interior to the base.

Dr. MOONEY. That is right.

Representative HOLIFIELD. Particularly in relation to freight-type of cargo.

Dr. MOONEY. That is right.

Representative HOLIFIELD. It would not change the factor of conveyance of personnel either way.

Dr. MOONEY. No; that is right.

Senator JACKSON. One C–124 was lost, Dr. Mooney, as I recall, a year ago last fall on a flight from Christ Church, New Zealand, to McMurdo Sound. McMurdo closed in and they were attempting to come in at the Hallott Station. The C–124 was there only for the purpose of preparing to transport heavy supplies into the Pole Station and the Byrd Station. It was lost en route on the mission; is that not correct?

Dr. MOONEY. That is correct.

Senator JACKSON. I think you lost half of the total here. How many were lost on that one flight?

Dr. MOONEY. Four men on that flight.

Senator JACKSON. On the C–124?

Dr. MOONEY. On the C–124. Wait a minute. Six.

Senator JACKSON. You do not fly a C–124 with four.

Dr. MOONEY. They didn't all die.

Representative HOLIFIELD. There were two C–124's that crashed, according to your list.

Dr. MOONEY. That is right.

Representative HOLIFIELD. That would account for 12 of the 17, apparently, would it not?

Dr. MOONEY. No. The one C–124 did not lose any lives.

Representative HOLIFIELD. There were two helicopters lost, apparently. That would probably not be in freight carrying, but local operations, I would think.

Dr. MOONEY. They carry both freight and passengers.

Representative HOLIFIELD. And one P–2B. We will put the statement of the Defense Department in the record as it is broken down. If it is not broken down properly, let us have it changed so it will be.

Did you have additional information, Colonel?

Colonel WILLIAMS. No, sir; I think you have jumped ahead into the last chart that I was going to present on the Pole and Byrd situation, unless you have further questions.

Representative HOLIFIELD. If it is not repetitive, go ahead and give us what you intended to give on that because we would like to have it

in an orderly way in the record. Sometimes the questions are not as consecutive as they might be.

Colonel WILLIAMS. Data on the Pole, Byrd, and McMurdo chart (p. 372) is based on preliminary figures from the contractor making the study. We do not have the final figures in yet.

Under McMurdo we show, first, a situation involving, on the second line there, three PM–1-type plants, and the various costs, and so on. These are the same as you have already seen. These are from the Kaiser figures.

If detailed planning and programing and budgeting and so on dictated that instead of going for three of these plants initially, we would go for two at McMurdo, then the second column of figures indicates the same items, the total project cost and the annual Department of Defense budgeted cost.

For Pole Station, on the asssumption that Pole would be one portable, low-power (PL) plant, we have the figures as indicated. You might note that the preliminary figures indicate that the conventional power costs at Pole are about 436 mills per kilowatt-hour. On Byrd Station, again PL-type, portable, low-power plant, the corresponding figures are shown.

The bottom line is the nuclear savings over a 20-year period based on the foregoing figures. That is all I have, sir.

Representative HOSMER. From that chart it looks like Byrd Station is the place to put it.

Colonel WILLIAMS. From the 20-year savings point of view, yes.

Representative HOSMER. The nuclear payout time is 1.3 years at Byrd Station, where the next, at the Pole, is 3 years, and McMurdo is between 5 and 8 years.

Colonel WILLIAMS. Of course, there are Navy operational matters intimately woven into this and which way the Navy would prefer to phase in first. In other words, building up McMurdo before they leap into the Byrd and Pole stations. These are details which should be very carefully worked out.

Representative HOLIFIELD. Colonel, I notice that the comparisons are the PM plants and the PL plants. Are you restricted to consideration of only the PM and PL plants for this use up there?

Colonel WILLIAMS. It happens, sir, that the PM plant is a 1,500 kilowatt size plant. The PL, we think, will be about 1,000 kilowatts. The PM will have probably considerably more packages than the PL. The PM we feel is further along in development. We have the final design, for example, on the PM–1. The final design for the PL is another year away.

General LUEDECKE. On a short-time scale it would appear that these would be the two most likely candidates rather than to say they are the only one.

Representative HOLIFIELD. It would be practical to consider these on a short-range basis, but on a longer range basis this would not rule out other types.

General LUEDECKE. That is correct.

Mr. FLOBERG. We do not intend to have any of these proposals run without competition. This would be on a bid basis. These are examples.

Representative HOLIFIELD. In other words, the offering in case this was authorized and appropriated, for bid, would be open to any contractor that wanted to participate in the bidding.

Mr. FLOBERG. As I say, the Commission has made no decision to that effect, but I do not see how we can do otherwise.

Representative HOLIFIELD. Are there any other questions?

If not, we will meet in the Old Supreme Court Room in the Capitol at 2 p.m.

(Whereupon, at 12:30 p.m., the subcommittee recessed, to reconvene at 2 p.m. the same day in the Old Supreme Court Room, the Capitol.)

AFTERNOON SESSION

Representative HOLIFIELD. The subcommittee will be in order.

At this time the Chair will recognize Congressman Gubser of California.

STATEMENT OF HON. CHARLES S. GUBSER, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Representative GUBSER. Mr. Chairman, with your permission, may I insert a statement in the record?

I represent the district in which this accelerator would be placed and I would like to be recorded as testifying in favor of it.

Representative HOLIFIELD. Your statement will be received, Congressman, and placed in the record.

(Mr. Gubser's statement follows:)

STATEMENT OF HON. CHARLES S. GUBSER IN SUPPORT OF PROPOSED AMENDMENT TO S. 3084 AND H.R. 10656, TO AUTHORIZE PROJECT 61-F-7, A LINEAR ELECTRON ACCELERATOR AT STANFORD UNIVERSITY

Mr. Chairman and members of the committee, I appreciate the opportunity of appearing before this committee in support of an amendment to section 101f of the atomic energy authorization bill to construct a linear electron accelerator at a cost of $107,200,000 at Stanford University.

During the 1st session of the 86th Congress, several bills were introduced, including my own, to authorize this project. During hearings held last year, it became apparent that additional information should be requested before such a substantial outlay of public funds was authorized. It is my understanding that this information has been secured and the doubts about the project raised at last year's hearings have been resolved in favor of the Stanford proposal.

The complete cooperation of the Stanford University board of trustees and the faculty at the university in providing this additional information is another evidence of the high caliber of scientific and business personnel who would administer the operation of this accelerator.

There is no need at present for me to presume upon the committee's time to repeat my testimony of last year, which dealt with the unique qualification of Stanford personnel to construct and operate this accelerator. There is no need for a repetition of the facts concerning the outstanding climatic and geographical conditions at Stanford University which support the proposal. All of this information is available in the testimony of last year.

In my opinion, the only new information which deserves emphasis is the fact that the proposal has successfully met several new tests and is still considered feasible after exhaustive investigation by some of our most competent people.

I have great faith in the ability of the membership of this committee. Without a doubt, each and every person is dedicated to the advancement of science in the field of atomic energy. I submit that the linear electron accelerator is required for proper advancement in the field of high energy nuclear physics. I urge the committee to approve the Stanford proposal.

Representative HOLIFIELD. We are very pleased to have before us as our first witness today, on the high energy physics items, Commissioner Dr. John H. Williams.

Dr. Williams, we are glad to see you up and hitting the ball again after your recent illness. We are happy to have you before us.

STATEMENTS OF JOHN H. McCONE, CHAIRMAN; JOHN F. FLOBERG, COMMISSIONER; DR. JOHN H. WILLIAMS, COMMISSIONER; DR. ROBERT WILSON, COMMISSIONER; GEN. A. R. LUEDECKE, GENERAL MANAGER; DR. FRANK PITTMAN, DIRECTOR, DIVISION OF REACTOR DEVELOPMENT; DR. PAUL W. McDANIEL, ACTING DIRECTOR, DIVISION OF RESEARCH; COL. D. G. WILLIAMS, ASSISTANT DIRECTOR FOR ARMY REACTORS; R. P. GODWIN, ASSISTANT DIRECTOR FOR MARITIME REACTORS, DIVISION OF REACTOR DEVELOPMENT, ATOMIC ENERGY COMMISSION

HIGH ENERGY PHYSICS

Dr. WILLIAMS. Thank you, indeed.

I am pleased to present to you and the members of this committee certain additional information on the authorization requirements for projects in support of the Commission's high energy physics program.

You have heard testimony earlier on the physical research projects included in the draft authorization bill. What I shall discuss today concerns the field of high energy physics and resultant amendments to the draft bill which reflect recent reviews of the Nation's entire high energy physics program.

In addition, I will provide information in an attempt to satisfy your request of Tuesday on the unique features, accomplishments, and objectives of our large accelerators.

Quoting from the PSAC–GAC (Piore) Panel report of February 5, 1960, transmitted to you on February 8, 1960, on the subject of high energy physics priorities, the Panel stated:

> For the preservation of this Nation's leadership, a program and level of support are required which include necessary components of all three categories of priorities: Adequate support, utilization, modification, and improvements of existing accelerators; completion and adequate instrumentation of accelerators now under construction; and the authorization of new accelerators in accord with challenging technical opportunities.
>
> The goal is to achieve a proper balance among these several components of the program and we must strive to accomplish this. Existing installations and those under construction represent an obligation which must not be ignored in future plans, or the effectiveness of the whole program will suffer. However, clearly in our view, the Nation would err seriously if budgetary limitations should prevent the authorization of new accelerator construction.

The main advances in the understanding of physics comes in rare, large steps, such as Newton's mechanics and Einstein's relativity. The last such large step was the development of quantum mechanics. Quantum mechanics was able to explain in great detail the building up of atoms from their constituent nuclei and electrons.

Quantum mechanics also explained some aspects of the building up of nuclei from protons and neutrons, but it left unanswered the de-

tailed nature of the protons and neutrons which are basic components of the nucleus. A complete understanding of the nature and interrelationships of these and the other elementary particles is not yet in sight. Indeed, this remains the central unsolved problem of physics today.

High energy physics is concerned with studying the properties of the fundamental particles which constitute matter, and with developing an understanding of their interactions. In order to produce most of these particles under controlled laboratory conditions, a high energy accelerator must be used.

A few years ago we felt that we were beginning to understand fundamental particles. There seemed to be only a few. However, the deeper we got into the problem, the more complex it became. Now it seems that there may be as many as 30 of these. Indeed, the Russians just 2 weeks ago announced the discovery at the Dubna Laboratory near Moscow of an anti-Sigma-minus hyperon—the most recent addition to the list of these so-called strange particles.

The discovery of many of these particles, and most of the knowledge we have gained about them, has been made possible by the development of improved electromagnetic machines capable of accelerating electrically charged particles to energies in excess of 1 billion electron volts.

The first two accelerators with this capability were the Brookhaven cosmotron and the Berkeley bevatron. As Mr. McCone stated Tuesday, the scientific accomplishments of these two accelerators have provided much of the basis for our Nation's preeminence in high energy physics.

Scientists at the Lawrence Radiation Laboratory, working with the bevatron, demonstrated the existence of antinucleons. These experiments gave a sound and firm basis to complex, theoretical studies which could be considered valid only if antiprotons and antineutrons actually existed.

However, a host of new problems was presented to the scientists by the demonstration of the reality of the antiparticles. Thus, it becomes necessary to answer many involved questions before we can have anything like an adequate understanding of fundamental particles.

Additional fundamental particles have been identified by scientists at the Lawrence Radiation Laboratory and Brookhaven National Laboratory. Some light is being shed on the interactions of these particles at the bevatron, but beams of higher intensity and higher energies are required to study these interactions properly.

In addition, the United States has two electron accelerators operating—the California Institute of Technology and Cornell synchrotrons with energies of 1.4 Bev. and 1.5 Bev., respectively.

Their main accomplishments have been to study the details of the photoproduction processes for pi-mesons and strange particles. The theoretical interpretation of these electromagnetic interactions is much simpler than for the corresponding particle production with protons observed at the cosmotron and the bevatron.

High energy accelerators—In operation

DOMESTIC

Machine	Energy, (Bev.)	Intensity	Particles	Location
Synchrotron	1.4	Average	Electron	California Institute of Technology.
Do	1.5	do	do	Cornell University.
Do	3.0	do	Proton	Brookhaven National Laboratory.
Do	6.2	do	do	University of California.

FOREIGN

Synchrotron	1.0	Average	Proton	University of Birmingham, United Kingdom.
Do	1.2	do	Electron	Rome, Italy.
Do	3.0	do	Protron	Saclay, France.
Do	10.0	Low	do	Dubna, U.S.S.R.
Do	28.0	Average	do	CERN, Geneva, Switzerland.

A comparison of our completed machines and foreign machines in the high energy range is shown on this chart. I have listed here the ones in operation. The first machines are called synchrotrons, as are the last, because they are all circular machines, meaning that the particle goes around in synchronism and gets a forward kick each time it passes by a section of the machine.

So the ones I have just been talking about, the Cal-Tech and the Cornell ones operate at the 1.4 and 1.5 Bev. level, the Brookhaven cosmotron at 3 Bev. and the synchrotron at the University of California at 6.2.

I have also listed the high energy accelerators in operation throughout the world. You see there is one electron and four proton machines, the second one being an electron machine. The energies range from 1 to 28 Bev. The one at 28 Bev. has just come in at Geneva and is giving some very interesting early results. So this is a comparison. We have four of these large machines running and the rest of the world has five.

Representative HOLIFIELD. That is the cooperative program at Geneva?

Dr. WILLIAMS. That is right. I think it is 12 European nations.

Representative HOLIFIELD. We are not cooperating in that?

Dr. WILLIAMS. We are not a part of the organization at all.

Representative HOLIFIELD. This is the highest Bev. synchrotron in the world now?

Dr. WILLIAMS. It is for a few months. Then Brookhaven will come in shortly, early this summer, we sincerely hope.

Representative HOLIFIELD. Brookhaven will be around 30 Bev.?

Dr. WILLIAMS. Yes.

Representative HOLIFIELD. We will have one at least equal and a little superior?

Dr. WILLIAMS. It depends on how they work in relative intensity and what they accomplish. When you are that close percentagewise in energy, it is who has the most in intensity that becomes important.

Representative HOLIFIELD. We have had the most experience in building these synchrotrons, have we not?

Dr. WILLIAMS. Yes.

Representative HOLIFIELD. I would assume that ours would be, if anything, more efficient in relation to the energy used than the foreign ones.

Dr. WILLIAMS. That is possible, but I do not think it is to be guaranteed because we have had a lot of people over in Geneva helping them and associated with them. I think their unique push on this has allowed them to come in a little earlier, if I make myself clear. That is our situation, then, in terms of the ones in operation.

From this table of mine, you can see, as the frontiers of science have been pushed back, it has been found necessary to build new machines, to develop new apparatus, and to refine the techniques for further experimentation.

To implement the Nation's effort in high energy physics, we believe that the program must contain the following steps:

(1) the construction of additional accelerators;

(2) the improvement of existing machines in order to realize their research potential more fully (the bevatron at the University of California is an example; and

(3) the development of new and sophisticated experimental techniques, data processing equipment, observational tools, and supporting laboratory facilities in general.

At this point I should like to show you this chart listing all of the large accelerators, both United States and foreign, now under construction.

High energy accelerators—Under construction

DOMESTIC

Machine	Energy (Bev.)	Intensity	Particles	Location
Synchrotron	3.0	High	Proton	Princeton University.
Do	6.0	do	Electron	Cambridge, Mass.
Do	12.5	do	Proton	Argonne National Laboratory.
Do	25–30	Average	do	Brookhaven National Laboratory.

FOREIGN

Linear accelerator	1.0	Average	Electron	Saclay, France.
Synchrotron	1.0	do	Proton	Delft, Netherlands.
Do	1.2	do	Electron	Lund, Sweden.
Do	1.3	do	do	Tokyo, Japan.
Linear accelerator	4.0	(?)	do	Kharkov, U.S.S.R.
Synchrotron	7.0	Average	Proton	Harwell, United Kingdom.
Do	7.0	do	do	Moscow, U.S.S.R.
Do	7.5	High	Electron	Hamburg, Germany.
Do	10.6	Very low	Proton	Canberra, Australia.
Do	50.0	(?)	do	Moscow, U.S.S.R.

This is a group which we hope to come in the next few months to a year and a half, and consists of the three proton accelerators and one electron accelerator, the one at Cambridge being the electron accelerator, in which we can go to 6.0 Bev.

The other three, the 3 Bev., 12½ Bev., and the 25 to 30 Bev., are coming along on a variety of schedules, but should all come in in the next year and a half.

The foreign ones which are under construction, nine of them, on which there are a couple of questions in the case of the Russian machines, we use as an illustration of the point that in order to continue with progress in this field we must continue to build new and more useful machines.

So in no case are we at this point, you might say, leading the world in this field. We are competitive with the rest of the world.

Representative HOLIFIELD. Why do you say that when our Brookhaven one comes in we will have the largest bevatron in existence? We have four building there and we have a number that are already in existence, a wide spread of them.

The only machine on there that shows superiority, it would seem to me, would be that last one, the 50 Bev., and we certainly do not have any definite information on that.

Dr. WILLIAMS. We do not know that is being built.

Representative HOLIFIELD. We do not even know it is being built. It has been announced, but we do not know what stage it is in. I would say from a domestic standpoint we are covering the field pretty well at the present time.

Dr. WILLIAMS. I would agree with you, except that I think the comparison between the Cern and Brookhaven accelerators does come out so narrowly in energy and we do not know what the intensity will be at Brookhaven until we run it. So we better call that a dead heat.

Representative HOLIFIELD. We will call it a dead heat, but we have a variety of instruments that they do not have at Cern or other countries.

Dr. WILLIAMS. They are building similar instruments to what we are building. They are not finished yet, nor are they at Brookhaven.

Representative HOLIFIELD. You would not want it said that at the present time we were behind?

Dr. WILLIAMS. No, I would not say that. Averaged against the world, we are about even with this construction.

Representative HOLIFIELD. We are operating more machines.

Dr. WILLIAMS. That is right.

Representative HOLIFIELD. There is no reason to think that we are behind.

Dr. WILLIAMS. I did not say we were behind, sir.

Representative HOLIFIELD. Or even that we are not ahead in view of the fact that we have more machines, more background of experimentation hours, more operational hours, you might say, in the field. I do not think we have to take off our hat to any nation at this time.

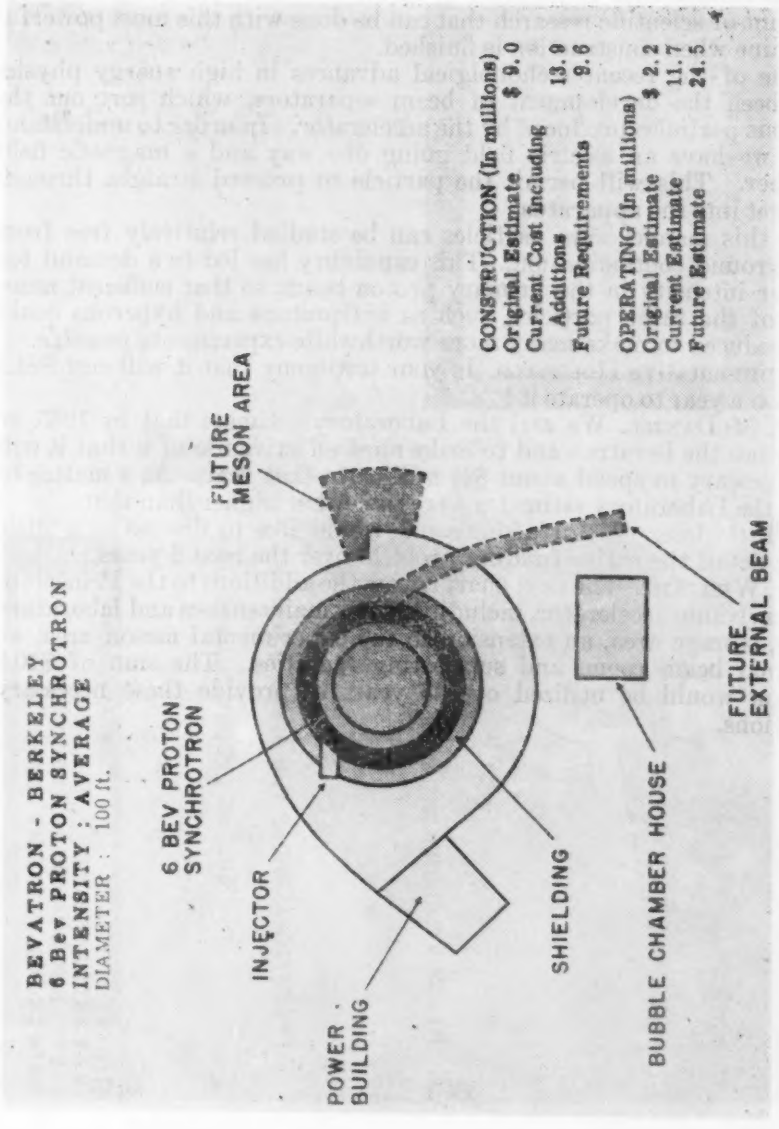
Dr. WILLIAMS. We do not have to take off our hat, but we have to watch if this thing becomes a matter of prestige and advancement that we do not stop at this point if we can possibly go ahead.

Turning then to page 5, the Commission proposes to initiate, in fiscal year 1961, work leading toward substantial expansion and improvement of the bevatron at Lawrence Radiation Laboratory, the Princeton-Pennsylvania proton accelerator, and the zero gradient synchrotron at Argonne National Laboratory, as well as to start construction of the Stanford University 2-mile electron accelerator project.

These proposals are in keeping with the recommendations of the Piore Panel for maximizing the usefulness of accelerators in operation or under construction.

The first of these four proposals provides for a major improvement program for the bevatron at Lawrence Radiation Laboratory. Specifically, this project will provide an increased beam intensity, increased experimental facilities, new primary and secondary external beams, and increased reliability and flexibility in the operation of the machine.

We have a chart here, sir, showing in small scale the existing 6-Bev. proton synchrotron at Berkeley. In this chart the captioned section represents the injector, so you can see how small that is compared to the synchrotron proper, which is the actual accelerator itself. The limitations that we are trying to overcome in this program, spread over the next 3 or 4 years, are simply the addition of shielding, represented by the gray areas both outside and inside the ring, and a power building, the future meson area, in which mesons will come out of the target area of the machine, and the dotted lines, representing the future external beam.


BEVATRON - BERKELEY
6 Bev PROTON SYNCHROTRON
INTENSITY : AVERAGE
DIAMETER : 100 ft.
CONSTRUCTION (In millions)
Original Estimate $ 9.0
Current Cost Including Additions 13.9
Future Requirements 9.6
OPERATING (In millions)
Original Estimate $ 2.2
Current Estimate 11.7
Future Estimate 24.5
FUTURE MESON AREA
6 BEV PROTON SYNCHROTRON
INJECTOR
POWER BUILDING
SHIELDING
BUBBLE CHAMBER HOUSE
FUTURE EXTERNAL BEAM

We do have at the moment the bubble chamber house, which many of you have seen, which is a most spectacular thing to see and you should not miss it if you are there. That is our program of how we would try to spend, with your permission, the $9.6 million to be accomplished over a period of 4 years.

We believe that is justified in terms of the major increase in the amount of scientific research that can be done with this most powerful machine when construction is finished.

One of the recent techonolgical advances in high energy physics has been the development of beam separators, which sort out the various particles produced by the accelerator. In order to understand this, we have an electric field going one way and a magnetic field another. This will permit the particle to proceed straight through and get into the apparatus.

In this manner rare particles can be studied relatively free from background contamination. This capability has led to a demand for higher intensity in the primary proton beam, so that sufficient numbers of the rarer particles, such as antiprotons and hyperons could be produced to make many more worthwhile experiments possible.

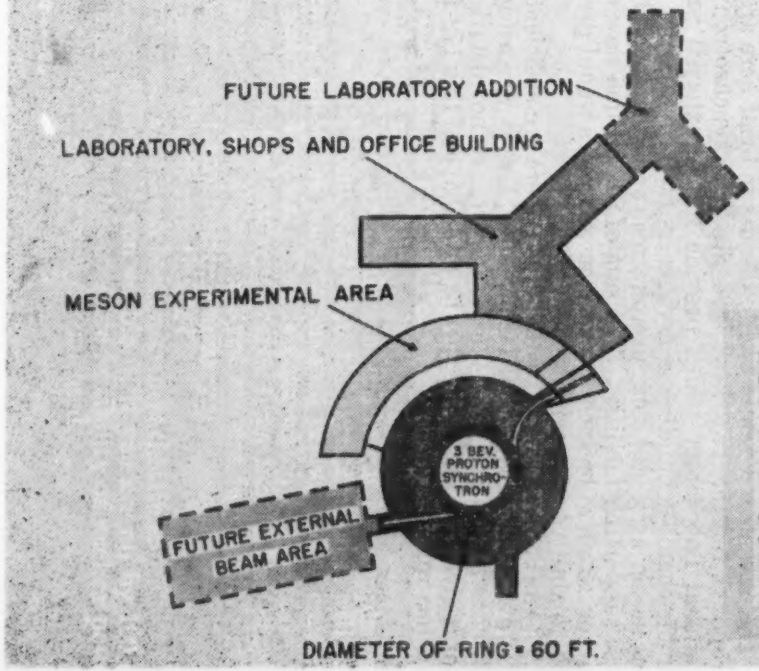
Representative HOLIFIELD. Is your testimony that it will cost $24.5 million a year to operate it?

Dr. MCDANIEL. We and the Laboratory estimate that by 1965, to fully use the bevatron and to make most effective use of it that it will be necessary to spend about $25 million in that year. As a matter of fact, the Laboratory estimates were somewhat higher than that.

A little later on this afternoon I would like to discuss in a little more detail the entire funding problem over the next 5 years.

Dr. WILLIAMS. The next chart covers the additions to the Princeton-Pennsylvania accelerator, including a new maintenance and laboratory wing, storage area, an extension to the experimental meson area, an external beam room, and supporting facilities. The sum of $10.8 million would be utilized over 3 years to provide these necessary additions.

PRINCETON - PENNSYLVANIA ACCELERATOR
3 Bev PROTON SYNCHROTRON
INTENSITY : HIGH
DIAMETER : 60 ft.


FUTURE LABORATORY ADDITION
LABORATORY, SHOPS AND OFFICE BUILDING
MESON EXPERIMENTAL AREA
3 BEV PROTON SYNCHRO-TRON
FUTURE EXTERNAL BEAM AREA
DIAMETER OF RING = 60 FT.

CONSTRUCTION (In millions)	
Original Estimate	$ 5.8
Current Estimate	11.2
Future Requirements	
Additions	10.8
Annual Requirements	.5

OPERATING - (In millions)	
Original Estimate	$ 1.0
Current Estimate	4.2
Future Estimate	5.0

The most important item is the provision of the external beam facilities. This machine was originally designed so that the experiments to be done were those contained in the target region which is the black circle. If the proper experiments at the next stage are done in this machine, then the proton beam will have to come out of the machine and be taken into this future external beam area.

Again, the small area represents the injector to this 3-Bev. synchrotron. The meson experimental area presently exists. The dark gray is the laboratory shops and office buildings which exist.

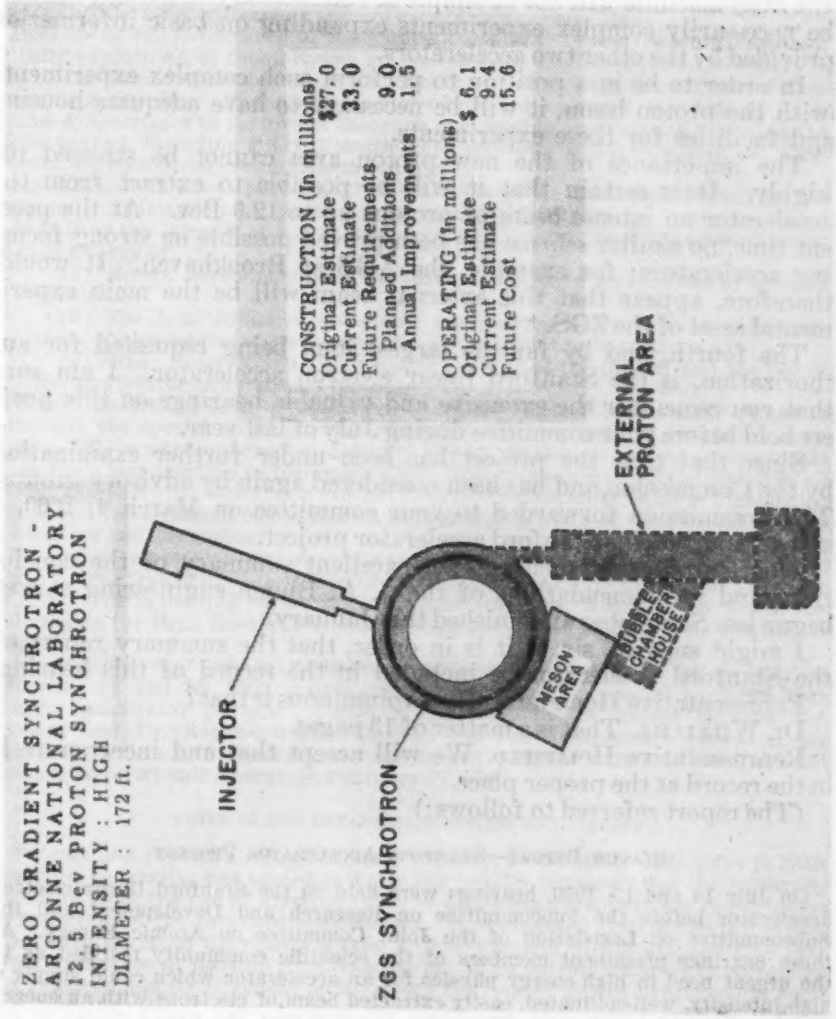
So we are thinking in terms of the two dotted areas plus ancillary equipment like motor generators and housing of various sorts to support those facilities. As I said, certain classes of experiments cannot be performed with the presently planned internal proton beam.

Experiments such as proton scattering, the study of direct proton interactions using bubble chambers, and detection of very short-lived particles would be practicable only with a well-shielded external proton beam.

This equipment is at Princeton and operated by the Pennsylvania-Princeton group.

The next item I would like to discuss in brief here are the changes proposed for the 12.5 Bev. zero gradient synchrotron at Argonne National Laboratory which provide for an external proton area, a bubble chamber building, a cryogenics facility, a power building for the meson area and new proton area, and certain additions to the base supporting facilities. The sum of $42 million now requested for authorization to be spent over the next 3 years would greatly enhance the capability of the original design.

These charts that you are looking at here are sufficiently simplified that many of these things I mentioned, like power areas and bubble chamber houses and things of that sort, are not detailed so clearly. But it gives you an idea of the size and shape of this 172-foot diameter synchrotron.


ZERO GRADIENT SYNCHROTRON -
ARGONNE NATIONAL LABORATORY
12.5 Bev PROTON SYNCHROTRON
INTENSITY : HIGH
DIAMETER : 172 ft.
CONSTRUCTION (In millions)
Original Estimate $27.0
Current Estimate 33.0
Future Requirements 9.0
Planned Additions 1.5
Annual Improvements
OPERATING (In millions)
Original Estimate $ 6.1
Current Estimate 9.4
Future Cost 15.6
EXTERNAL PROTON AREA
INJECTOR
ZGS SYNCHROTRON
MESON AREA
BUBBLE CHAMBER HOUSE

53759—60——26

In the initial phase of construction of the ZGS project, the external proton areas consisted merely of outside concrete pads with no supporting facilities. This type of experimental area is suitable only for the more rudimentary experiments with very simple equipment.

By the time the ZGS comes into operation in the summer of 1962, both the Brookhaven and CERN machines will have been in operation for 2 years. It is, therefore, clear that the experiments to be done on the ZGS machine will not be simple or rudimentary in nature, but will be necessarily complex experiments expanding on basic information provided by the other two accelerators.

In order to be in a position to perform such complex experiments with the proton beam, it will be necessary to have adequate housing and facilities for these experiments.

The importance of the new proton area cannot be stressed too highly. It is certain that it will be possible to extract from the accelerator an intense beam of protons up to 12.5 Bev. At the present time, no similar scheme has been proved possible on strong focusing accelerators; for example, the AGS at Brookhaven. It would, therefore, appear that this external beam will be the main experimental asset of the ZGS.

The fourth, and by far the largest item being requested for authorization, is the Stanford linear electron accelerator. I am sure that you remember the extensive and valuable hearings on this project held before your committee during July of last year.

Since that time the project has been under further examination by the Commission and has been considered again by advisory groups. The Commission forwarded to your committee on March 4, 1960, a status report on the Stanford accelerator project.

This status report contains an excellent summary of the conclusions and recommendations of the J. A. Blume engineering survey begun last September and finished this January.

I might suggest, sir, if it is in order, that the summary report of the Stanford accelerator be included in the record of this hearing.

Representative HOLIFIELD. How voluminous is that?

Dr. WILLIAMS. That is a matter of 13 pages.

Representative HOLIFIELD. We will accept that and incorporate it in the record at the proper place.

(The report referred to follows:)

STATUS REPORT—STANFORD ACCELERATOR PROJECT

On July 14 and 15, 1959, hearings were held on the Stanford linear electron accelerator before the Subcommittee on Research and Development and the Subcommittee on Legislation of the Joint Committee on Atomic Energy. At these hearings prominent members of the scientific community testified as to the urgent need in high-energy physics for an accelerator which could supply a high-intensity, well-collinated, easily extracted beam of electrons with an energy in the region of 10–15 Bev. They also testified that the linear design is the only one which can fill these requirements in a practical way, and that the Stanford University group is uniquely qualified to design, construct, and operate such an accelerator.

The Chairman of the Atomic Energy Commission made a visit to Stanford on July 19, 1959, and discussed the proposed accelerator with Stanford and project personnel. As a result of this visit and following his return to Washington, Mr. McCone raised a number of questions on the project including such points as the earthquake hazard, alinement of the accelerator tube, the total estimated cost and scope of the project, the emphasis on high-energy physics, and the possibility of a conflict of interest involving Varian Associates and Stanford

University personnel. This last item involved patent holdings, rights to manufacture, and the distribution of royalties on klystron tubes.

In addition, during the month of August, the Joint Committee on Atomic Energy raised certain questions covering patent rights on accelerator components, patent provisions to be included in the contract with Stanford, the distribution of royalties on klystron sales, the basic organizational and administrative policies governing the use of the accelerator, the provision of power for operation of the accelerator, and the conflict-of-interest problem involving Stanford project personnel and commercial companies which might be sources of supply for various accelerator components.

Because of the importance of these questions and the extensive effort required to fully explore all of them, it was not possible for the Commission to report in full to the Joint Committee on Atomic Energy prior to the adjournment of Congress in September. Commission actions included engaging the firm of J. A. Blume & Associates to perform a thorough engineering analysis and report on the entire project, including study of earthquake problems and cost estimates. Four months were required to complete this study.

No official action was taken by the Joint Committee on Atomic Energy on the proposed authorization bill prior to adjournment of Congress.

It is thus the purpose of the present report to inform the Joint Committee on Atomic Energy of:

(*a*) Recent developments on the patents, royalties, and conflict of interest questions;

(*b*) The J. A. Blume & Associates' engineering report dealing with questions of site location, cost estimates, and earthquake hazards; and

(*c*) Other items such as the supply of power to the project and the use of the accelerator as a national facility.

Before discussing each of the above items in detail, it seems appropriate to note that the special panel on high energy accelerator physics (Stanford hearings, p. 527) was reconvened on January 19 and 20, 1960, to review developments since their last meeting in November 1958. Also present and participating in all except the executive sessions were members of the National Science Foundation Panel and the technical committee on high energy physics of the Federal Council for Science and Technology.

The panel statement and recommendations strongly endorsing the Stanford project were transmitted to the Joint Committee on Atomic Energy on February 8, 1960. The panel had before it for consideration the "Summary of Fiscal Requirements for High Energy Physics through fiscal year 1965," a copy of which is attached.

In addition, the President's Science Advisory Committee at its meeting on February 14 and 15, 1960, considered the report of the special panel on high energy accelerator physics. Copies of an exchange of letters between Mr. Floberg and Dr. Kistiakowsky reflecting the full Committee's views on the Stanford project and the field of high energy physics were sent to the Joint Committee on Atomic Energy on February 27, 1960.

PATENTS AND ROYALTIES, CONFLICT OF INTEREST

Patents and royalties.—As previously reported in our letter of October 8, 1959, Stanford University has agreed to waive any royalty payments due the university resulting from the use of klystron tubes or other components in the construction or operation of the proposed accelerators. It is expected that in the prime contract with Stanford University a type A patent article will be employed, i.e., the usual arrangement used by the Commission. If an outside contract is negotiated for research and development on klystrons the type of patent arrangement to be incorporated would depend upon the industrial and patent position of the contractor. If the company had an industrial and patent position as respects klystrons the incorporation of a type C patent article may be appropriate. Under such type provision the contractor would retain exclusive commercial rights for use of any inventions resulting from the contract for purposes other than use in the production or utilization of special nuclear material or atomic energy. However, the Government would retain a nonexclusive, irrevocable, royalty-free license for all Government use. An appropriate background license will be incorporated where the facts warrant. If Stanford issues purchase orders for commercially available klystrons, an indemnity in favor of the Government will be secured, and if the seller is obligated under a license agreement to pay royalties to Stanford, negotiations will have to be consummated to reflect the waiver by Stanford of

its share of any royalties under the Sperry-Rand agreement. In connection with the patents on accelerators held by Stanford University and manufactured by Varian Associates, these patents were obtained under a Government-supported contract (Office of Naval Reserach), and the Government holds royalty-free right. In addition the Varian Associates resolution (discussed under conflict of interest) also applies.

In connection with the spectroscope patents (electroparamagnetic resonance and nuclear magnetic resonance equipment) held jointly by Prof. Felix Bloch of the Stanford physics department and the estate of W. W. Hansen, it is not contemplated that such items of equipment will be used by the project. Furthermore Professor Bloch is not expected to be connected with the project and the Varian resolution will apply.

The Commission will take every precaution to protect the Government's interest as a result of the extensive research and development program planned on certain accelerator components.

Conflict of interest.—Following his visit to Stanford on July 19, 1959, the Chairman of the Atomic Energy Commission raised certain questions on klystron patents and royalties involving Varian Associates and Stanford University as well as interests in Varian Associates held by Stanford personnel.

In a letter to Mr. McCone dated September 2, 1959, Senator Anderson raised the question of Stanford employees having interests in firms which might be active in the manufacture of klystrons and other components which would be used on the 2-mile accelerator. At the request of Senator Anderson, the Division of Inspection of the AEC interviewed the Stanford personnel involved as to their connections with companies which were engaged in the design and manufacture of microwave equipment. The report of the Division of Inspection was transmitted to the Joint Committee on Atomic Energy on October 8, 1959. It was immediately apparent that the firm which had by far the closest connection with the microwave laboratory at Stanford was Varian Associates. As a result of discussions held between the various interested parties as to how this conflict of interest could be resolved, Varian Associates, on November 20, 1959, adopted the following resolution:

"*Be it resolved*, That Varian Associates disqualify itself from bidding on any contracts in connection with the construction of the proposed 2-mile accelerator,

"*Be it further resolved*, That should the Government of the United States, through the Atomic Energy Commission or one of its other agencies, request the cooperation of Varian Associates, then Varian Associates stands ready to cooperate, but only under the condition that it be without profit to Varian Associates."

In addition to the above, Stanford has proposed some policies and procedures which they believe will prove effective in eliminating any conflict of interest. These are as follows:

(*a*) Typical AEC contracts provide that the AEC shall review and approve or disapprove any proposed subcontract which involves either research and development work or large expenditures. Thus, by contract, the AEC would have the right in all significant cases to disapprove a proposed procurement for any number of reasons, including conflict of interest.

(*b*) Stanford would disqualify bidders if it appeared that conflict of interest was involved in a proposed procurement, provided that it would be possible and suitable for Stanford to do so. If it were not possible for Stanford to disqualify, then it would refer the matter to the AEC for appropriate action.

(*c*) Each person employed on the project would be required not to perform consultant services for any firm regarding any item which is to be procured for the project, unless he receive prior approval from the AEC and from Stanford. Stanford would follow good common practice in writing specifications and providing needed background information on a nonexclusive basis to all reasonable competent and qualified bidders in order to encourage a maximum of competition. The cost of such specification and information work would be borne by the project.

The Commission believes that policies and procedures of this general type can be worked out which will effectively deal with this problem.

J. A. BLUME ENGINEERING REPORT

In September 1959 the Commission contracted with John A. Blume & Associates, engineers, a San Francisco engineering firm with considerable experience in the design of earthquake-resistant structures, for a study of the accelerator project with particular reference to (1) earthquake risk and general site feasibility, (2) a review and analysis of the design and construction costs of the entire project for the proposed tunnel site on Stanford land, and (3) a survey of the area within a 15-mile radius of Stanford for other possible sites including the earthquake risk and complete cost estimates for such sites. A summary of the results and conclusions and their recommendations follows:

(*a*) The proposed Stanford Tunnel site will be costly to develop and the particular site is not adaptable to cut-and-cover construction.

(*b*) The proposed tunnel site offers very little flexibility once the tunnels are built; many provisions for ultimate operations have to be built into a tunnel scheme at the outset.

(*c*) The costs for ventilating, cooling, and installing equipment in tunnels are much higher than for buildings.

(*d*) Within a radius of 15 miles of Stanford five different sites were analyzed with project construction cost estimates ranging from $107.2 to $126.7 million. Of these possible locations Moffett Field site is not recommended because of possible soil problems and the earthquake risk.

(*e*) There are two feasible cut-and-cover sites on Stanford lands, each of which is estimated to cost less to develop than the Coyote Hills site.

(*f*) The estimated cost of constructing the proposed facility at the Stanford cut-and-cover sites is from $17.5 to $19.5 million less than at the Stanford Tunnel site.

(*g*) Each Stanford cut-and-cover site (Sand Hill and Felt Lake) is acceptable from earthquake risk and other considerations. Other factors being equal, it is preferable not to construct heavy fills that can become saturated such as could occur along the Felt Lake alinement. In view of this factor, the cost differential and the fact that no additional land would have to be acquired, the Sand Hill site is recommended over the Felt Lake site.

(*h*) The project is practical and feasible. The solution which offers the best combination of least total costs, least stage I cost, greatest flexibility for future phases, acceptable earthquake risk, and preferable location in relation to existing scientific facilities, is the Sand Hill site located on Stanford University lands. The estimated project cost for stage I construction on this site is $107,200,000.

It should be also noted that the Blume report estimated the cost for conversion to stage II (an increase from 10 to 20 Bev. to about 45 Bev.), if ever required, is $45 million.

Dr. Edward Ginzton, of Stanford University, has stated that he is in general agreement with the conclusions and recommendations of the Blume report. Mr. Moulton, special assistant to the president of Stanford, has advised that the university will make the San Hill site available on a long-term lease at no cost to the Government. However, Stanford feels it must have indemnification from third-party liabilities.

POWER REQUIREMENTS, USE AS NATIONAL FACILITY

Power requirements.—Preliminary reports on the study now being made of the feasibility of bringing power from the Bonneville Power Administration system to the San Francisco area show that no firm power, but only secondary or nonfirm power, can be made available in California by the proposed interconnection of power systems. Furthermore, even though the delivered cost of such nonfirm power would be relatively low, the total cost of power supply, including backup to provide the firm power requirements, would be higher than for power secured from the Central Valley project of the Bureau of Reclamation.

The Bureau of Reclamation officials have notified the AEC that although no power is presently available, adequate firm power from generating plants now building or to be built in the Trinity River Division is scheduled to be available

in June 1963. They also state that no action has been taken with respect to the allocation of this new block of power. The Acting Commissioner of the Bureau of Reclamation has advised that AEC's request for the allocation of 50,000 kilowatts for the Sanford project has been sent to the regional director at Sacramento, so that it will be on file at such time as allocations are made for Trinity power. It is estimated that this power will cost approximately 4.6 mills per kilowatt-hour as compared with 9.3 mills per kilowatt-hour if purchased from Pacific Gas & Electric Co., affording a saving of $660,000 per year.

The Bureau of Reclamation was also informed that a possibility would exist in the future for an increase in the power requirements to 120,000 kilowatts, if stage II were authorized for the accelerator. In this case the availability of public power would result in an annual saving of $1,300,000.

Use of the accelerator as a national facility.—The PSAC–GAC panel statement emphasized these major accelerators should be regarded as national facilities having national and international importance.

Stanford University recognizes quite fully both the national character of the proposed accelerator and its own responsibilities in operation of the machine and supervision of its research program.

Dr. Ginzton, in his testimony during the Stanford hearing, said (Stanford hearings, p. 102): "We should like to repeat what you have heard stated by others, we propose to make the facility, upon completion, available to qualified scientists without regard to their normal residence. We fully recognize that despite the fact that construction of the proposed 2-mile machine can only be carried out by Stanford personnel at the present time, the expenditure of so large a sum of money would necessarily place this activity in the class of a national facility. We propose to assure this arrangement by creating a suitable administrative structure with participation from many universities and other establishments."

The AEC will have the right of approving any organizational arrangement which is made, as was stated in a letter of August 17, 1959, from Mr. McCone to Senator Anderson:

"I can give you every assurance that the Commission will have the right to approve in advance the basic organizational and administrative policies governing the use of this national facility. This right of approval will be incorporated in the basic contract agreement between the USAEC and Stanford University."

Summary of fiscal requirements (cost basis) for high-energy physics

[In thousands]

Agency	Fiscal year 1959	Fiscal year 1960	Fiscal year 1961	Fiscal year 1962	Fiscal year 1963	Fiscal year 1964	Fiscal year 1965
Atomic Energy Commission:							
Operations	$24,976*	$34,134	$42,751	$63,005	$73,689	$85,116	$100,793
Equipment	2,441*	5,685	9,133	12,700	13,210	14,950	17,160
General plant projects	318*	718	1,000	3,000	2,850	3,400	4,150
Construction	17,689*	23,098	22,889	54,838	62,875	45,100	31,930
Total	45,424	63,635	75,773	133,543	152,624	148,566	154,033
Department of Defense:							
Office of Naval Research	3,400	4,000	2,500	5,300	6,000	6,700	7,600
Office of Scientific Research	1,500	1,500	1,800	2,100	2,500	3,000	3,600
Total	4,900	5,500	4,300	7,400	8,500	9,700	11,200
National Science Foundation	850	900	3,000	4,100	5,200	6,300	7,400
Undesignated projects	0	0	0	2,500	17,000	52,000	50,000
Grand total	51,174	70,035	83,073	147,543	183,324	216,566	222,633

Dr. WILLIAMS. Further detailed information, which has an important bearing on the Stanford proposal, is contained in the full Blume report forwarded to your committee on February 27, 1960.

The Commission, after careful consideration of the recommendations of the PSAC-GAC Panel, which was reassembled by action of Dr. Kistiakowsky and Mr. McCone, has reaffirmed its earlier strong

recommendation that the Stanford project should be undertaken as soon as possible.

(A letter dated February 5, 1960, from E. R. Priore, Chairman, Special Panel on High Energy Accelator Physics, follows:)

THE PRESIDENT'S SCIENCE ADVISORY COMMITTEE,
Washington, D.C., February 5, 1960.

Hon. JOHN A. MCCONE,
Chairman, U.S. Atomic Energy Commission,
Washington, D.C.

Hon. G. B. KISTIAKOWSKY,
Chairman, President's Science Advisory Committee,
Washington, D.C.

GENTLEMEN: The Special Panel on High Energy Accelerator Physics, appointed by the President's Science Advisory Committee and the General Advisory Committee to the Atomic Energy Commission, reconvened on January 19 and 20, 1960, to review its report of a year ago. Profs. Geoffrey Chew and Richard Feynman were special consultants to the Panel and participated in this review. Members of the Advisory Panel on High Energy Accelerators to the National Science Foundation, and the Technical Committee on High Energy Physics of the Federal Council for Science and Technology attended all but the executive sessions.

The Panel wishes to endorse unanimously its recommendations of last year. The NSF panel members with whom this Panel met were also in full agreement with the recommendations of that report. The special consultants and others present at the meeting also agreed unanimously with the substance of the recommendations. In particular, this Panel wishes to reaffirm its recommendation to start immediately the construction of the linear electron accelerator proposed by Stanford University, and to express its concern about the delay which has been encountered in authorizing this machine to date. All the experimental potentialities of this machine, which the Panel foresaw last year, still look as attractive as they did then. In addition, new potentialities have developed for which this high-intensity, high-energy, electron machine is well suited.

In the course of considering the Stanford accelerator, the need for a high-intensity proton accelerator also was discussed. The Panel concluded that a need still exists for a high-intensity proton accelerator of at least 8 Bev.

At present the United States is leading the world in high-energy physics, one of the most dynamic areas of science, which, as a byproduct, is training some of our brightest physicists. To maintain this leadership, to continue the growth of this science and to continue the training of some of our best minds, requires vigorous support by the Federal Government. The Panel is concerned that the fiscal year 1961 budget for high-energy physics, as submitted to the Congress, is too low. The reduced construction obligation envisaged for fiscal year 1961, as compared with fiscal year 1960, implies a level of activity in the future which may jeopardize our present leading position in the world in this field. The authorization of the Stanford accelerator and other anticipated construction over the next 5 years, which the Panel considers essential for an effective development of the high-energy physics field, will require an increasing annual expenditure for high-energy physics which may approach some $200 million by 1965.

The Panel also feels that it should clarify the set of priorities stated in its report of November 1958 (par. 12(c)). For the preservation of this Nation's leadership, a program and level of support are required which include necessary components of all three categories of priorities: adequate support, utilization, modification, and improvement of existing accelerators; completion and adequate instrumentation of accelerators now under construction; and the authorization of new accelerators in accord with challenging technical opportunities. The goal is to achieve a proper balance among these several components of the program and we must strive to accomplish this. Existing installations and those under construction represent an obligation which must not be ignored in future plans, or the effectiveness of the whole program will suffer. However, clearly in our view, the Nation would err seriously if budgetary limitations should prevent the authorization of new accelerator construction.

The Panel would like to emphasize that the very large accelerators, wherever they may be located, should be regarded as national facilities having national

and international importance. Special efforts should be made to make them fully available to the scientific community on the basis of scientific merits of the work to be undertaken.

Sincerely yours,

E. R. PIORE,
Chairman, Special Panel on High Energy Accelerator Physics.
JESSE W. BEAMS,
HANS A. BETHE,
LELAND J. HAWORTH,
EDWIN M. MCMILLAN,
Members.
GEOFFREY E. CHEW,
RICHARD FEYNMAN,
Special Consultants.

Enclosures:

(1) List of members and special consultants on Panel.
(2) List of participants, Jan. 19–20 meeting of Special Panel.

SPECIAL PANEL OF THE PRESIDENT'S SCIENCE ADVISORY COMMITTEE AND THE GENERAL ADVISORY COMMITTEE TO THE ATOMIC ENERGY COMMISSION ON HIGH ENERGY ACCELERATOR PHYSICS

MEMBERS

Dr. Emanuel R. Piore, chairman, director of research, International Business Machines, Corp., 590 Madison Avenue, New York, N.Y.

Dr. Jesse W. Beams, Department of Physics, University of Virginia, Richmond, Va.

Dr. Hans A. Bethe, professor of physics, Laboratory of Nuclear Studies, Cornell University, Ithaca, N.Y.

Dr. L. J. Haworth, director, Brookhaven National Laboratory, Upton, Long Island, N.Y.

Dr. Edwin M. McMillan, director, Lawrence Radiation Laboratory, University of California, Livermore, Calif.

SPECIAL CONSULTANTS

Dr. Geoffrey F. Chew, professor of physics, University of California, Berkeley, Calif.

Dr. Richard Feynman, professor of physics, California Institute of Technology, Pasadena, Calif.

TECHNICAL ASSISTANT

Mr. George D. Lukes, the President's Science Advisory Committee, Executive Office Building, Room 287, Washington, D.C.

PARTICIPANTS IN THE JANUARY 19–20, 1960, MEETING OF THE SPECIAL PANEL OF THE PRESIDENT'S SCIENCE ADVISORY COMMITTEE AND THE GENERAL ADVISORY COMMITTEE TO THE ATOMIC ENERGY COMMISSION ON HIGH ENERGY ACCELERATOR PHYSICS HELD IN ROOM 220, EXECUTIVE OFFICE BUILDING, WASHINGTON, D.C.

MEMBERS OF THE PANEL

Dr. Emanuel R. Piore, Chairman, International Business Machine Corp.
Dr. Jesse W. Beams, University of Virginia.
Dr. Hans A. Bethe, Cornell University.
Dr. L. J. Haworth, Brookhaven National Laboratory.
Dr. Edwin M. McMillan, Lawrence Radiation Laboratory.

SPECIAL CONSULTANTS

Dr. Geoffrey F. Chew, University of California.
Dr. Richard Feynman, California Institute of Technology.

INVITED PARTICIPANTS

Members of the Advisory Panel on High Energy Accelerators to the National Science Foundation:
Dr. L. J. Haworth, Chairman, Brookhaven National Laboratory.
Dr. H. L. Anderson, University of Chicago.
Dr. H. R. Crane, University of Michigan.
Dr. B. J. Lofgren, University of California.
Dr. L. I. Schiff, Stanford University.
Dr. R. Serber, Columbia University.
Dr. M. G. White, Princeton University.
Dr. R. R. Wilson, Cornell University.
Members of the Technical Committee on High Energy Physics of the Federal Council for Science and Technology:
Dr. R. M. Robertson, Chairman, National Science Foundation.
Donald C. Holmes for J. T. Holloway, Department of Defense.
Dr. H. W. Koch, National Bureau of Standards.
Dr. G. A. Kolstad, Atomic Energy Commission.
Dr. Paul W. McDaniel, Atomic Energy Commission.
Dr. W. E. Wright, Office of Naval Research.
Dr. J. Howard McMillen, National Science Foundation.

OTHER

Dr. Wolfgang K. H. Panofsky, Stanford University.
Dr. Glenn M. Frye, Jr., Atomic Energy Commission.
Dr. Robert J. Riddell, Jr., Atomic Energy Commission.

The 10 to 20 Bev. electron linear accelerator proposed by Stanford University should be the next major step in the high-energy physics program of the country. The construction and operation of this machine will put in the hands of the U.S. physicists a most necessary tool if we are to achieve maximum scientific progress.

In conclusion, let me briefly state the various scientific areas which the scientific community feels should be explored, and for which the Stanford accelerator would be eminently suited.

Specifically, it will:

1. Provide a greatly enhanced source of antinucleons and strange particles and, hence, permit more meaningful experiments on the reactions which these particles may generate.

2. Permit much more extensive and accurate studies of electromagnetic particle production processes. Electrons do not interact via nuclear-type forces and, therefore, provide a convenient tool for disentangling electromagnetic effects from nuclear ones.

3. Make possible far more accurate and detailed studies of the structure of nucleons and the extension of such studies to other particles. These studies of the "shapes and sizes" of nucleons are very important to our understanding of these particles.

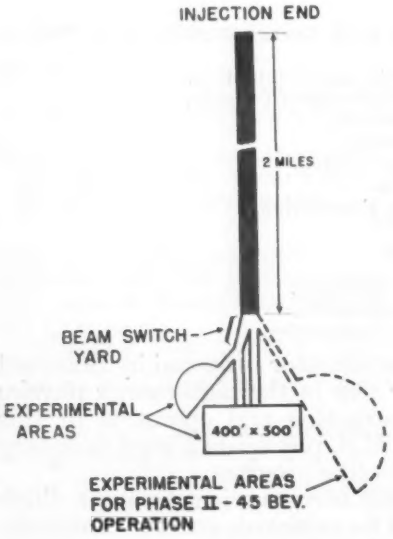
4. Extend to much shorter distances our knowledge of the laws of electrocmagnetic interactions and possibly disclose anomalies of profound significance.

5. Make possible the detection of hitherto unknown particles which could be produced by the process of electromagnetic pair production.

Mr. Chairman, I have finished my prepared statement. Dr. McDaniel and the staff are here and will assist me in answering any questions the committee may have.

I think we ought not to close without seeing the chart of the Stanford accelerator here. You see, it has to be broken into two parts because the solid section is 2 miles long and the end section is of the order of 500 feet long, which are the experimental areas for the first series of experiments.

STANFORD TWO-MILE LINEAR ELECTRON ACCELERATOR
INTENSITY : VERY HIGH



CONSTRUCTION - (In millions)	
Original Estimate	$105.0
Current Estimate	107.2
Possible Future Requirements	60.0
OPERATING - (In millions)	
Original Estimate	$ 15.0
Current Estimate	15.0-20.0
Future Estimate (No estimate available for operation at 45 Bev)	

Representative HOLIFIELD. Thank you, Dr. Williams, for your statement.

Is it not true that scientific staff assigned to low-energy accelerator projects are leaving these projects for the more exciting and possibly better provided for high-energy physics projects?

Dr. WILLIAMS. My personal knowledge would lead me to deny that allegation because at the University of Minnesota some years ago they built a 68-million-volt machine and I find people want to come and join it rather than move to high-energy machines. I think the low-energy-physics business is well supported and well staffed.

Representative HOLIFIELD. You do not think they are leaving that for this more exciting field?

Dr. WILLIAMS. No, I do not, sir.

Representative HOLIFIELD. What are the figures for the total scientific staff in low-energy physics and separately for high-energy projects?

Dr. WILLIAMS. The thing changes so rapidly, we have not made an addition of these numbers for a year or a year and a half, so if we could provide that for the record we would be very happy.

Representative HOLIFIELD. Please provide that for the record.

Dr. WILLIAMS. Thank you.

(The material to be furnished follows:)

As of December 31, 1959, the AEC's physical research program employed the following number of scientific man-years in the respective fields:

	Scientific man-years
High energy physics	520

In addition there were 355 graduate students employed under the research projects.

Low energy physics	430

In addition there were 438 graduate students employed under the research projects.

Representative HOLIFIELD. Is it possible in your opinion to pool some of these extremely expensive items such as large magnets and hydrogen chambers and let them be shared to a greater extent than we have done in the past?

Dr. WILLIAMS. Yes, I think that is possible because the present general policy is to have only one large bubble chamber near each of these major accelerators and to shift around these mass spectrometers proves to be a rather cumbersome job. They weigh literally tons and tons. It is hard to move them and transport them and set them up. In fact, they are in continual use at each machine.

I think we are economizing as well as we can by using the same mass spectrometer for many different experiments around a given machine. This is the maximum economy that we can see.

Representative HOLIFIELD. We have made some extracts from the special President's panel of November 25, 1958, and there is indicated three priorities in paragraph 12 under "Policy Considerations and Conclusions":

First priority should be given to fullest utilization of existing accelerators, including their modification and the continuing provision of new instrumentation; next priority should be given to adequate facilities for effective use of the accelerators now under construction; and next in importance is the construction of new accelerators required for the exploration of new scientific phenomena beyond the capabilities of existing accelerators and the provision of university facilities.

The Stanford linear accelerator project falls within this third category here, and the question I ask you is: Have the first two parts been adequately considered and provided for under the present AEC authorization request?

Dr. WILLIAMS. I would say the answer is "Yes." The details could probably be better explained by Dr. McDaniel.

Dr. MCDANIEL. I think, as we get into the rest of the afternoon and talk over the individual requirements of the specific accelerators, there may be some cases where we are not providing the total amount of funds that the individual laboratory feels it should have next year.

But on balance, I believe it is fair to say that we are taking care of the existing accelerators and the research work with them to a reasonable degree. We are not goldplating any particular machinery, and I believe when the fact is considered that we are spending Government money, I believe we are taking care of all of our accelerators to just about the proper limit.

Representative HOLIFIELD. There are two major programs there. Project 61–f–2, which is the Princeton, N.J., accelerator——

Dr. MCDANIEL. At the Princeton-Pennsylvania accelerator, we have in our request before this committee the sum of $10 million.

Representative HOLIFIELD. About $9,500,000 more than it was.

Dr. MCDANIEL. That is correct. We have a requirement of $10,800,000 as an authorization requirement. We have an obligation request of the appropriating committees of $1.350 million to take care of the laboratory wing of the additions, and a small storage area. The remaining obligations will be requested in future years.

Representative HOLIFIELD. Your next major one is project 61–f–6, where you raise the $1,100,000 up to $9,600,000, or about an $8,500,000 increase.

Dr. MCDANIEL. At the Lawrence Radiation Laboratory, as Dr. Williams and Mr. McCone explained, there will be an additional requirement, as shown on this chart, to provide additional external beam, additional meson area, shielding, and an improved injector. These add up to a total requirement of $9.6 million.

That chart shows $10 million, but it should be $9.6 million. Of that, we have an obligational requirement in fiscal year 1961 for $1.1 million for additional shielding and $450,000 for what we call accelerator additions and modifications of the bevatron improvement type. The difference between the $1.550 million and the $9.6 million will be obligational requirements in future years.

LINEAR ELECTION ACCELERATOR

Representative HOLIFIELD. Getting back to the proposed Stanford linear accelerator, what are the prospects of obtaining scientific staff for this project? That is, qualified people to use this tool.

Dr. MCDANIEL. The representatives of Stanford University have advised us that they foresee no difficulty at all in staffing this accelerator and the project associated with it. They are here today and I believe they could reaffirm that if you would like to ask them. Dr. Ginzton is in the room.

Representative HOLIFIELD. Dr. Ginzton, do you wish to come forward and answer that question?

The question was: Do you think you will have any trouble in staffing this large accelerator?

STATEMENT OF DR. EDWARD GINZTON, MICROWAVE LABORATORY, STANFORD UNIVERSITY

Dr. GINZTON. No, Mr. Chairman; none whatever. This is regarded as one of the most exciting projects of all time in nuclear physics. People have applied for the privilege of participating in this project from all over the world—England, Switzerland, India, everywhere.

Representative HOLIFIELD. These people would be transferred from existing projects on lower energy or lower capacity machines, would they not?

Dr. GINZTON. In some cases, yes. In many cases they would be coming from projects which have been completed. For example, we have a number of people who would like to come to us from the CERN project in Geneva. We have a substantial number of people at Stan-

ford who have been working with us. There are also many new graduates coming along every year who would love to work in this field.

Representative HOLIFIELD. There is a shortage of tools of this kind in relation to the people who are using them?

Dr. GINZTON. No, sir; there is no real shortage. Dr. Williams and Dr. McDaniel could probably answer better.

Dr. WILLIAMS. I am not sure Dr. Ginzton really understood your question.

Representative HOLIFIELD. I do not think you understood the content of my question. I referred to the accelerators as scientific tools. I said that there is a shortage at this time, according to your proposal, of the proper kind of tools for the use of scientists, and there is a multitude of scientists, apparently, that could use them if you had them.

Dr. WILLIAMS. I would agree with you, Mr. Holifield, that we are short on the fundamental tools on which to proceed rapidly in our further discoveries in high energy physics.

Representative HOLIFIELD. Dr. Ginzton, can you tell us what the plans are at Stanford for staffing the technical and administrative part of this project? What are your planning ideas in management? Do you have them firm or are you more or less waiting to find out what we do?

Dr. GINZTON. A large measure are waiting approval of the project. We do have a key staff of approximately 50 people at the present time in various categories. We know that a large number of people would like to be employed by this project, but at the moment we have made no specific plans to proceed.

Representative HOSMER. Isn't it a fact that you have a fairly good-sized, competent body of people working on your present linear accelerator?

Dr. GINZTON. Yes, sir; we do. We have a group of people, roughly 300 in number, who are working in this general field. We would like to employ the bulk of these people in research along the lines they are now doing. But a significant fraction will be available for participation in the new project.

Representative HOLIFIELD. Will you remain at the table, please, Dr. Ginzton? We may have other questions for you.

Maybe this question should be directed to General Luedecke. Where do you expect to get the $18 million to operate this project, General? Is that from the operating funds?

General LUEDECKE. The $18 million refers to research and development during the period of construction which we would expect to come from operating funds. The $15 to $20 million mentioned yesterday we would expect, after it was in operation, to come from operating funds.

Representative HOLIFIELD. Have you made an additional request for $18 million in your operating funds for this, or are you cutting down some of the existing programs in order to find it?

Dr. MCDANIEL. The $18 million you refer to is to be spent over a 6-year period. The requirement for fiscal year 1961 amounts to only $2.5 million, of which, I believe, we have plans now for requesting that amount in a supplemental appropriation if the Stanford accelerator is authorized. So in the first year there would be $2.5 million spent of the $18 million.

Representative HOLIFIELD. You said you planned to put it in the supplemental.

Dr. MCDANIEL. It will be in the supplemental provided the Stanford accelerator is authorized.

Mr. RAMEY. Supplemental to your current appropriation?

Dr. MCDANIEL. I think it is simply an amendment that will be consolidated with the regular budget request.

General LUEDECKE. Depending on the time that the project was authorized. If it was authorized in time, we would include it in the original budget request.

Representative HOLIFIELD. On page 9, the 1960 status report says Dr. Ginzton is in general agreement with the conclusions of the Blume report. Does this mean you have some reservations on the Blume report, Dr. Ginzton?

Dr. GINZTON. No, sir; I do not.

Representative HOLIFIELD. You have no reservation?

Dr. GINZTON. No, sir.

Representative HOLIFIELD. Is the contemplated arrangement on this project with Stanford University one which calls for a standard fee during the operating period?

Dr. MCDANIEL. The details of the construction contract have not as yet been consummated with the university, largely because the project has not yet been authorized. I personally suspect that Stanford University would request a fee during this construction period, but the exact size has not been revealed to us.

Representative HOLIFIELD. Mr. Chairman, last year you took the position——

Dr. MCDANIEL. I am informed that Stanford University has not requested a fee.

Mr. BURROWS. I think what you meant by a fee is a payment for overhead rather than a fee in the sense of a profit.

Dr. MCDANIEL. So there will not be a fee requested by Stanford University is what I am advised.

Dr. GINZTON. Mr. Chairman, Stanford has always made it plain that it wishes to have this project conducted at Stanford on a "no-loss-no-gain principle in the true sense of these words. The rest of it depends upon specific arrangements with Stanford in the contract negotiations, library services, and other things of a minor nature.

Mr. RAMEY. On your construction arrangements, have you done any more thinking on how much of this the Commission would handle by direct contract and advertising for bids and so on, like your service facilities? It could be AEC for almost all of your conventional construction and Stanford handling the machine itself.

Dr. MCDANIEL. Again there has not been a complete agreement between the university and the Government as to the method of contracting, largely because we are waiting to see whether the project will, in fact, be authorized. Discussions have been going forward.

Representative HOSMER. I would assume that you would select the most economical method of going about it, would you not?

Dr. MCDANIEL. Certainly, and the most efficient. The question of economy would have to be balanced against efficiency and looking toward the best interests of the American people both from saving money and from producing the best machine. These two factors would

be weighed carefully by both Stanford University and by the Commission.

Representative HOLIFIELD. Last year, Mr. Chairman, you asked that this Stanford project be considered as a separate and independent piece of authorizing legislation. Now with its presentation at this time, it becomes an item in the annual authorization bill. It raises the amount requested from $171,256,000 to $293,876,000.

Was there any particular reason why you have presented it at this time?

Mr. MCCONE. Yes. Last year, as my memory serves me, you had acted on our original authorization bill before the decision was made by the President to ask for this authorization. For that reason it was submitted to you separately.

Representative HOLIFIELD. It was a matter of timing.

Mr. MCCONE. It was a matter of timing; yes, sir.

Representative HOLIFIELD. I think we reported the bill out of committee, but it had not been acted on on the floor.

Mr. MCCONE. The 1960 authorization bill, yes.

Representative HOLIFIELD. We had quite a discussion, as you remember—Senator Anderson participated in it, and Mr. Price was also quite interested in this point—of the policy you use in the operation and the construction of facilities by the Federal Government on the private university campuses.

Have you ever made a determination on that point, sir?

Mr. MCCONE. Yes, we have gone into that quite carefully. I think it is clearly understood that this and other facilities that are on university campuses are recognized as national facilities, and, therefore, are to be used as such, and are not to be used exclusively by the university.

Representative HOLIFIELD. What arrangements do you make with a university such as Stanford for the location of this accelerator? Do you arrange it on the basis of a lease to the Government of the property, or an agreement for its management and control? How do you go about it?

Mr. MCCONE. In this particular instance we will lease the property at no rental or nominal rental of $1 a year for a period that will be not less than 50 years, and perhaps 99 years.

Representative HOLIFIELD. Do you have joint management boards in these cases, or does the control remain in the Federal Government? I am speaking now of the operation of the accelerator and the control of who uses it and the allocation of time and that sort of thing.

Mr. MCCONE. The accelerator will be operated by Stanford University, under a contract similar to the Berkeley contract. That contract will provide for a satisfactory degree of control and voice by the Commission as to how the facilities are to be operated and how they are to be made available to the entire scientific fraternity.

Representative HOLIFIELD. You feel that your lease terms for the land are satisfactory. Have you a general agreement or have you actually signed an agreement?

Mr. MCCONE. No; we have not actually signed. We are agreed in principle. I have no reason to believe that the detailed lease will not be in a form satisfactory to us. The board of trustees of Stanford University has taken this matter under cognizance and have agreed to

make the 400-odd acres of land available to us on the terms that I have just expressed.

I would like to point out to you that this is quite a sacrifice, you might say, from the standpoint of Stanford University. It is very valuable land and land which they would dispose of in due time for either residential or industrial purposes.

They considered very carefully whether this was an appropriate use or whether they were properly discharging their responsibilities as trustees of Stanford University. They concluded that this was a proper thing for them to do. It was not a decision that was made lightly, however. It was made after careful consideration by the board.

Representative HOLIFIELD. There is no doubt that they were influenced by the fact that this is probably the most expensive scientific tool ever conceived by the mind of man. It will bring them a great deal of prestige.

Mr. MCCONE. It will be both expensive and valuable. I think it will bring to Stanford University great prestige worldwide. While this is an accelerator, it will also be a magnet for excellent students and for professors and teachers and scientists to take residence at Stanford.

Representative HOSMER. Isn't this to some extent an extension of the prestige of the university by the fact that the klystrons were developed there?

Mr. MCCONE. That is right.

Representative HOSMER. This is a logical extension.

Mr. MCCONE. It is a logical extension. This machine is made possible by a very great deal of very fundamental research carried on by Stanford University for a period of years. It not only makes this machine possible, but it has contributed enormously to many areas of our defense effort both during the war and since.

Representative HOSMER. I think whatever student newspaper they have down there at the university should take note that you, a University of California graduate, and Dr. Ginzton the same, and myself the same, are all here working for the Stanford project.

Mr. MCCONE. I am afraid they are suspicious about the destiny of this authorization act, Mr. Hosmer, for that reason.

Representative HOSMER. I would like to ask Dr. Ginzton if he has ever heard of a street called Sandhill Road?

Dr. GINZTON. Unfortunately, I have, sir.

Representative HOSMER. Why do you say unfortunately?

Dr. GINZTON. I think lots of residents of our part of California cherish oak-studded hills more than they cherish anything else.

Representative HOSMER. As a matter of fact, this will parallel Sandhill Road.

Dr. GINZTON. Yes, sir.

Representative HOSMER. On the other side of Sandhill Road is a residential development.

Dr. GINZTON. Yes. Actually at the present time it is open country and many people in that part of California would like to see it remain as uncommitted land forever.

Representative HOSMER. Let us say from the standpoint of the residential area across the way or somewhere in the vicinity, there is no radiation hazard or anything like that?

Dr. GINZTON. No, sir; there is no radiation hazard at all.

Representative HOSMER. There was a press report that something in the nature of a tower equivalent to a 10-story building was going to dominate the landscape. That is not a fact, is it?

Dr. GINZTON. There is no tower as such. But you are right nonetheless. There is a large building, a part of a complex of buildings or laboratory facilities of all kinds. One of the buildings as presently visualized is a building approximately 400 by 500 by 100 feet high.

Representative HOSMER. Is it contemplated that will be an ugly building or a building unsuitable for the general excellence of the landscape around there?

Dr. GINZTON. Considering the size of the general laboratory development, I don't think it will be particularly ugly. As a matter of fact, I think it will be a very pleasant facility, including other buildings which will tend to minimize its size.

Representative HOSMER. You have a medical school and a hospital installed on the campus recently. That is a building of roughly equivalent size.

Dr. GINZTON. Yes, it is.

Representative HOSMER. As I recall that was one of the architectural beauties of the West.

Dr. GINZTON. We like to think so.

Representative HOSMER. This would be carried on in the same general spirit that the university has always carried on its construction activities, I imagine.

Dr. GINZTON. Yes, sir.

Dr. MCDANIEL. I would like to answer that a little bit differently. We are building an accelerator for research in science and high-energy physics at Stanford University. While we do not wish to detract from the esthetic beauties of the landscape, we will certainly design this building with economy in mind, efficiency in mind, and esthetic approaches will be last on our list. I don't mean to imply that we will design an ugly building, but whether or not it conforms with all of the beauties of California, I am not prepared to say at the moment.

Representative HOSMER. They are probably incomparable, anyway. Let me ask you this. Are you agreeable to working with the local county zoning people and those who have an interest in it?

Dr. MCDANIEL. I am certain that our engineers who will be in charge of the design criteria for this building will work very effectively with the local authorities and will not design an eyesore. I can assure you of that.

Representative HOSMER. Everything within reason will be done that needs to be done to make it suitable.

Dr. MCDANIEL. Yes, sir.

Representative HOSMER. I ask these questions because our good friend, Congressman Younger, brought them up, and I think they

ought to be a matter of record. I think there is no one here that would feel anything would be done out there that would violate good taste. I think it is well to bring it out now and allay any fears.

Representative HOLIFIELD. The committee has the telegram, a copy of which was sent to Congressman Younger, and it might be well to read it into the record at this point. It is addressed to the Senate and House Atomic Energy Committee as follows:

Ladera Community Association representing more than 350 families residing adjacent and overlooking the site proposed for the Stanford linear accelerator urges that full consideration be given to its impact on the surrounding communities. These communities situated on rolling hills are exclusively residential and heretofore no public consideration has been given to uses other than residential. The entire area has been designated for low density residential uses in the master plan of San Mateo County. Although not necessarily opposed to the installation as such we are concerned with the appearance of the proposed cut in cover and massive buildings the effect on use of adjoining lands, increase in traffic on local roads, and the possibility that this installation will prevent the development of a system of streets and highways needed to serve this rapidly growing area.

This telegram was signed by the president of the Ladera Community Association, Mr. Kenneth Carey, with a notation that a copy was sent to Representative Younger.

Congressman Hosmer's remarks on this subject are very pertinent. I assume it would be unavoidable that roads crossing this particular 2-mile linear line would be impossible. If there were roads needed, they would have to parallel it rather than cross it.

Dr. GINZTON. Mr. Chairman, it is possible to have roads cross the site where necessary. I think it should be made a matter of record that one of the first developments which is scheduled to take place in that area is the North-South Freeway which will alter grossly the appearance and usefulness of the entire site. Our proposed accelerator would be another principal addition. But it is pointless to think of that land for the future as hills forever; there will be gross changes. We shall be careful in our planning.

Representative HOLIFIELD. Would the new proposed freeway parallel the present direction of the accelerator?

Dr. GINZTON. No, sir; it would cross it, in fact. If you like, I can show you the artist's sketch now which shows the appearance of that part of the countryside.

Representative HOLIFIELD. Very well.

Dr. GINZTON. This is an artist's drawing—but quite an accurate one—which shows the community of Ladera from which you just heard the telegram. Here is the accelerator crossing this countryside like this, and this being the so-called tower, Mr. Hosmer, that you spoke of.

Representative HOSMER. It looks more like a building.

Dr. GINZTON. It is part of a laboratory complex. It is not really a single building but a complex of buildings, of which this is the tallest part. The thing I want to emphasize here is that any principal resident of this community would, first of all, see a major freeway which crosses right in front of the community. The freeway, in fact, will dominate that whole area.

Representative HOLIFIELD. The linear construction would be behind the first range of hills, apparently.

Dr. GINZTON. That is right. Another view of this proposed accelerator from the back from these hills is shown here. This is the accelerator again. This is the same laboratory complex. This again is the major freeway. As you can see, the highway and the accelerator are roughly of the same order of magnitude of structures insofar as disturbance is concerned.

Representative HOSMER. That accelerator with cut and fill is roughly comparable to the cut and fill you have on the highway going through there.

Dr. GINZTON. That is right.

Representative HOSMER. Would it be landscaped and so forth?

Dr. GINZTON. Yes; the cuts will have to have erosion control. By the time this fully develops, we don't think the cuts will be particularly different from the normal hillsides.

Mr. RAMEY. Will roads go over it with a bridge?

Dr. GINZTON. Yes. The major freeway could go over the proposed accelerator. This is an example of how other roads might cross, if it is necessary.

Perhaps you can see these prints a little bit better.

Representative HOLIFIELD. According to these pictures here—may we retain these for our files?

Dr. GINZTON. You may if you wish.

Representative HOLIFIELD. I would not see anything particularly objectionable from the standpoint of community beauty of any kind.

Dr. GINZTON. Mr. Chairman, if properly handled, we believe this laboratory complex can blend into the sphere of development of this area quite naturally and will be an asset rather than a detriment.

Representative HOSMER. It will be roughly along the same lines of the industrial area on the other side of the campus.

Dr. GINZTON. It will be, hopefully, better. It is a coordinated area development, and is possible to plan it more carefully than planning 100 separate industrial plants.

Representative HOSMER. The industrial plants look like nice office buildings.

Dr. GINZTON. We like to think so, sir.

Representative HOLIFIELD. You first planned this as a tunnel. Then you changed to a cut and cover. What was your consideration there? Expense?

Dr. GINZTON. Yes, sir. We first proposed to build this accelerator in two tunnels. We carefully explained originally that we did not have the money to explore geologically the soil where the tunnel was to be bored. After a careful exploration by the AEC, it turned out that the tunnels were considerably more expensive than originally anticipated. The suggestion was made by a number of people which showed that by using this so-called cut-and-fill method, it would save a great deal of money.

Representative HOLIFIELD. We have before us table X–1, I believe, of May 15, 1959, of the Blume report, which bears the original estimate and the current estimate and the different sites involved there. Apparently you have chosen the most economical site there.

Dr. GINZTON. The choice of the present site, Mr. Chairman, has been principally on the basis of lowest cost.

Mr. RAMEY. Are there any other changes of significance in the cost of your facility other than the matter of your tunnel aspect? In other words, as we recall the original estimate was $105 million, and then taking that same estimate today it would be $126,700,000. Do some of those increases in that $126 million stay in your estimate as it is now, but you save some money by changing the site and putting it above ground?

Dr. GINZTON. Yes, this is in large measure correct. It is not the complete story. What happens is that first by abandoning the tunnels and going to cut and cover construction the ventilation problems in the tunnel are much different. Much of the equipment we now suggest is different from the equipment we suggested before. This includes cooling, ventilation, electrical equipment, fire protection system; many things are different. So it is not any longer possible to identify individual costs.

Mr. RAMEY. I notice, for example, on the accelerator itself, item C–5, in the original estimate, it is $23,789,000. Then it goes to $28 million in the revised estimate of the Blume report, but it stays up about $28 million all the way across.

Dr. GINZTON. Yes. I think it is very difficult to discuss in any fine detail at the present moment the differences between the various columns that you see there. I think I should point out to you that there are many things that have been changed by going to cut and fill. It is no longer possible to identify numbers simply; ventilation is completely different.

Mr. RAMEY. Are there any other change in design or other aspects of the accelerator between last year's presentation and now?

Dr. GINZTON. The parameters which we listed before are identical with those used now. Specifications are identical. Methods of accomplishing some of the specifications in the Blume report are different than we originally suggested. Blume conducted, in some cases, more careful studies than we have and as a result some costs are different from ours. In some cases we accept on face value Blume's recommendations, because they have had more engineering attention than ours.

Representative VAN ZANDT. Mr. McCone, the recommendation of this accelerator stemmed from the President's Advisory Committee, did it not?

Mr. MCCONE. No, the recommendation stems from the report of a committee that was created by the Science Advisory Committee or the Scientific Adviser to the President, and the Atomic Energy Commission. It was made up of representatives from the Scientific Advisory Committee and the General Advisory Committee to the Atomic Energy Commission.

Representative VAN ZANDT. Was there not an urgency tag attached to the project last year when first presented to the committee?

Mr. MCCONE. Yes, there was.

Representative VAN ZANDT. Some problems developed that required additional study?

Mr. MCCONE. That is right.

Representative VAN ZANDT. Mostly related primarily to real estate?

Mr. MCCONE. They related to several matters, of which real estate was one. They related first to the question of the adequacy of the design and the specifications and the consequent construction estimate. It was in order to resolve those uncertainties that the Blume Co. was employed by the Commission. Also, there was some question about the design of the tunnels to withstand possible impact of earthquakes. This resulted in our authorizing Stanford to proceed with drilling and certain exploration work. The result of that work proved that there was no particular earthquake hazard, but there were subsurface conditions which would substantially increase the cost of the tunnel.

Representative VAN ZANDT. Did you look at any other site?

Mr. MCCONE. Yes; we looked at five sites as reported by Blume. The Sandhill site turned out to be the most satisfactory, both because of its proximity to the university and total cost.

Representative VAN ZANDT. Does the same urgency exist today that existed last year?

Mr. MCCONE. I think there is an element of urgency here, because this machine is unique from all machines either in existence or under construction or being considered in any part of the world. This will place us in the position where we will be exploring a particular frontier of science that no one else can explore.

Representative VAN ZANDT. If this project was delayed a year, it would seriously handicap our efforts in this particular field; would it not?

Mr. MCCONE. We would think it would be a mistake to delay it. The scientific fraternity have criticized the Commission for the delay of the last year. We feel, however, that has not been a year lost, because we feel that the investigatory work that we initiated and have carried on at some considerable expense during the year was very worthwhile.

Representative VAN ZANDT. How long would it take to construct this accelerator?

Mr. MCCONE. About 5 or 6 years. That might be expedited somewhat.

Representative VAN ZANDT. Dr. Williams, did I understand you to say that in manning this accelerator you would not have to take personnel from other accelerators affecting their operation in any way?

Dr. WILLIAMS. I think on the average the answer to your question is yes, it will not seriously disturb the status quo because of an additional number of people coming into the field, this being a single unit. These things, I think in the course of the 5 or 6 years to build, will come up with no serious perturbation on the distribution of scientific personnel.

Representative HOSMER. As a matter of fact, there will be new people in it. I saw a lot of high-school kids on the smaller one.

Dr. WILLIAMS. Don't count on high-school kids coming out with Ph. D.'s in physics in 5 years, because they will not. There are people now in college who will contribute to this when the time comes around. I want to point out that the high-school kids are probably a little farther back in the pipeline.

Representative VAN ZANDT. Is it not true the locating of this accelerator on the Stanford campus is primarily because of the experience they have gained over a period of years and the personnel they have there already?

Dr. WILLIAMS. That is true, Mr. Van Zandt. I think both circumstances, the fact that these are a competent group of people and they have developed the radio frequency tools to use it, gives them a forefront position. In fact, if we had an application or proposal from some other group to do this, we would be very hesitant to come to you and ask you for this sort of support.

Representative VAN ZANDT. That is all, Mr. Chairman.

Representative HOSMER. Mr. McCone, we had some questions about patents last year. I understand in your status report you included it. Would you briefly dispose of that problem?

Mr. MCCONE. Yes. If you will recall, the patents for the klystron are held by five parties. The Hansen estate, the Varian Brothers, as individuals, the Sperry Corp., and Stanford University. Stanford University was to receive, I believe, 22½ percent for royalties. Stanford by action of their board waived their royalties on the klystron tube to go into this machine. The remainder of the royalties will be paid to Sperry and to the Hansen Estate, and Sigurd and Russell Varian as individuals. This, in our opinion, is in order because these were developments made at their own cost and patented under the regular patent processes.

There was another problem which arose which was a possible conflict of interest, because a number of the Stanford faculty were interested in Varian Associates. Varian Associates is a manufacturing company located adjacent to Stanford University, and one of its products was the klystron tube. Also, this firm was in a position to manufacture other components that would go into this accelerator. This was resolved by the board of directors of Varian Associates by declaration removing Varian Associates as bidder or supplier of goods and services for this project.

Representative HOLIFIELD. Does this mean that we would be denied the use of this tube?

Mr. MCCONE. No; we would not be denied the use of it. We would go to other manufacturers. There are several licensees and several qualified manufacturers.

Representative HOLIFIELD. How about this third party, the Hansen estate? They would still obtain their royalties as a matter of right?

Mr. MCCONE. Yes; the estate would retain its royalties.

Representative HOSMER. They have no connection with the university?

Mr. MCCONE. It has no connection.

Dr. GINZTON. I think I would like, first of all, to observe that we are talking about two kinds of things which we ought to differentiate in our minds.

First, we are apparently referring to royalties on the klystron tube. Then, in addition to that, there may be thousands of other items which might be patentable or patented by others.

Representative HOLIFIELD. In the future.

Dr. GINZTON. Or even in the present. Any "valve" or "plug" or "thing" might be patented by somebody. If I use this microphone, I might have to pay royalties to somebody. Let us focus our attention on the royalties to the klystron tube. The klystron tube was invented at Stanford by the Varian brothers in 1937. The patent which describes the klystron which is needed for this project expired in February of this year and there will be no royalties paid to the inventors by anybody, by Stanford or anybody else, on the klystron tube needed for this project.

Representative HOLIFIELD. Have they made improvements on it which renew their patent right?

Dr. GINZTON. Stanford University does not own any improvement patents on this klystron. Stanford University will not derive any royalties on this particular device.

Representative HOLIFIELD. There are other improvements on the tube, however, which would require royalties if it is used; are there not?

Dr. GINZTON. I am not aware of any. There may be some, it is true. There may be on thousands of other items.

Representative HOLIFIELD. Is this particular tube one that you desire very much because of its excellence over other types of tubes?

Dr. GINZTON. That is right.

Representative HOLIFIELD. You do plan to use it?

Dr. GINZTON. Yes. I would like to reiterate that on the patents which Stanford owns and on which royalties are normally distributed to Sperry-Rand, Stanford University, to two Varian brothers, and the Hansen estate, these royalties will be zero on the klystrons needed for this project.

Representative VAN ZANDT. I understand that as of February all rights to royalties have expired as far as Stanford University and the firms you mentioned.

Dr. GINZTON. For the particular klystron tube.

Representative VAN ZANDT. For the particular tube to be used in this accelerator.

Dr. GINZTON. Yes, sir.

Representative HOLIFIELD. Mr. Ramey?

Mr. RAMEY. On the matter of utilizing Varian Bros., haven't they been the principal klystron manufacturer? Are the other companies not, in amounts of tubes produced, somewhat small?

Dr. GINZTON. It is Varian Associates, and not "Bros." They are one of about eight firms in the United States that are fully qualified to build klystrons for the project. There are many other famous firms qualified to perform the work needed.

Mr. RAMEY. But isn't Varian Bros. up to date the outfit that has made most of these tubes?

Dr. GINZTON. For existing machines or klystrons of this general class?

Mr. RAMEY. Either or both.

Dr. GINZTON. In the first instance, Varian's have not made any klystrons for the Stanford accelerator. We have about 50 klystrons in operation at Stanford. These have all been built at Stanford by the Stanford staff. As for the general question of klystrons of this type, I would say that the answer is "No."

I think other manufacturers have built as many if not more klystron tubes of this particular class, size, and power. Varian comes close to being the first, but it is very close.

NOTE.—The following excerpt is quoted from the Varian Associates Prospectus dated July 28, 1959, furnished to the Joint Committee by the AEC: "The Company was one of the pioneers in the development of these [Klystron] tubes and is presently the free world's largest producer of them in terms of dollar volume."

Representative HOLIFIELD. General Luedecke, last year we put a number of letters in the record to and from the Commission. Do you have any other letters of more recent date that you would like to present to be printed in the hearings at this point on this subject?

General LUEDECKE. No, sir; I believe not. I believe our status report would cover that.

Representative HOSMER. So we understand a little bit more about this klystron tube, what it actually does, it just generates a very high frequency wave, does it not?

Dr. GINZTON. Yes, sir.

Representative HOSMER. The klystron tube is the heart of the radar?

Dr. GINZTON. Yes, sir.

Representative HOSMER. What you do is boost your particles along on these waves and bring more power in every few feet along the line?

Dr. GINZTON. Yes, sir. It is a powerful radio transmitter essential in radar and useful in this application.

Representative HOSMER. Will it disrupt the television and radio reception of the people living in the community adjacent there?

Dr. GINZTON. No, sir. The power is confined in metal containers completely. It is not permitted to escape.

Representative HOSMER. If it were permitted to escape, your machine would not be doing its work?

Dr. GINZTON. We would be wasting taxpayers' money.

Representative VAN ZANDT. Mr. McCone, last year when we were considering this project, the question of power requirements was discussed. Can you bring us up to date as to the developments?

Mr. MCCONE. As I said in my statement yesterday, we made application for 50,000 kilowatts of power from the Bureau of Reclamation who, as you know, have extensive developments in that area in California. We have also indicated a possible future need of a total of 120,000 kilowatts, which would be the power requirement.

Representative VAN ZANDT. This would be California power and not to the north?

Mr. MCCONE. That is right; it would be California power.

Representative VAN ZANDT. Not piped from the north?

Mr. MCCONE. No. It would be in the reclamation projects in California. We filed with the Bureau of Reclamation indicating this requirement so that they could use it for planning purposes and also to reserve block power for us.

Representative VAN ZANDT. Will this project be entitled to a priority as far as power is concerned?

Mr. MCCONE. I cannot answer that, Mr. Van Zandt. I do not know of any reason that it should have a priority.

Representative HOSMER. It is a preference customer.

Mr. MCCONE. It might be established as a preference customer. I think by stating our requirement at this early date we have arranged so that there will be a block of power set aside for us.

Representative VAN ZANDT. Am I to understand that the idea of getting power from the Northwest was fully explored and proved to be impractical?

Mr. MCCONE. Others here could speak to this. Mr. Derry could speak to it. There is a question of the power from the north not being firm power. Of course, this needs firm power.

STATEMENT OF JOHN DERRY, DIRECTOR, DIVISION OF CONSTRUCTION AND SUPPLY, ATOMIC ENERGY COMMISSION

Mr. DERRY. I am John Derry, Director of Construction and Supply.

Last year, as the result of the hearing, questions raised by Senator Anderson, we talked with the Bureau of Reclamation, Bonneville Power Administration, and registered our interest in power from the Northwest and consideration in the intertie that was being discussed at that time between the public utilities and the private utilities in trying to build a powerline between the Bonneville Power Administration and California.

All we did with them was register our interest and be sure that we were considered in this so that our consideration of the power requirements on the Stanford accelerator would be considered along with everything else.

The hearings, as I understand, are inconclusive. The report has been submitted. But I think it has been objected to by one party or the other.

The principal conclusion, I think, that one can reach so far as the Bonneville Power Administration is concerned, and the power from the Northwest, that only dump power is available. Firm power is not available below the California line.

Then our only other recourse was to go to the Bureau of Reclamation and the Department of the Interior and ask them if there was any chance in the Trinity part of the Bureau of Reclamation and whether or not power in that area would be available in the foreseeable future.

After considering our requirements, they said yes, there was a chance. Power is not available now. But during the course of the next 3 years, and beginning in 1963, power will become available and we have registered our requirements with them for 50,000 kilowatts.

This will be considered with the other requirements in this area. As Mr. McCone said, we registered our requirement early enough so that will probably stand in the preferential status of getting power before anyone else.

This will essentially cut the power cost in half on the accelerator, from an estimated cost of something like 9.3 mills down to 4.6 mills.

Representative HOLIFIELD. If you get the Trinity power?

Mr. DERRY. Yes, sir.

Representative HOLIFIELD. An estimate has been made that the Trinity power will be needed for other purposes. Is that not true?

Mr. DERRY. All the Trinity power now is committed, Mr. Chairman. There will be supplemental power coming in over the course of the next 3 to 6 years. The accelerator project would be eligible for being served from the Trinity project.

Representative HOLIFIELD. On the other hand, if the nuclear power adaptation was put through on the plutonium reactor at Hanford, there would be quite a bit more power in that grid.

Mr. DERRY. Yes, sir. But that would go into the Bonneville Power Administration grid.

Representative HOSMER. It would not be firm power.

Mr. DERRY. That is probably something of separate discussion. It seems to me it is not considered firm power.

Representative HOSMER. There is no question about it; it is not firm power.

Mr. DERRY. Anyway, it would not be available to the customers below the California line.

Chairman ANDERSON. What was the answer? It would or would not be firm power?

Mr. DERRY. I am not in a position to answer that one. I guess it would not be, but I do not know.

Chairman ANDERSON. You mean the Hanford reactor might break down with some regularity?

Mr. DERRY. No, sir. We do not think it will break down, Senator.

Chairman ANDERSON. What would keep it from being firm, then?

Mr. DERRY. I am not a qualified witness, Senator, to speak on this subject.

Chairman ANDERSON. Then I would not answer the question in the first place.

Mr. DERRY. I would prefer not to answer the question because I am not qualified.

Representative VAN ZANDT. Mr. Chairman, I have one more question.

In the event this project is authorized, it will amount to $107,200,000. You plan to fund it over a period of 6 years, do you not?

Mr. MCCONE. Yes; that is right.

Representative VAN ZANDT. For fiscal year 1961 you would ask for $4.2 million obligation and $2 million in appropriations.

Mr. MCCONE. $2,200,000.

Representative VAN ZANDT. Then you would progressively increase the amount each fiscal year until it was all funded by 1966.

Mr. MCCONE. Yes; that is correct.

Representative HOLIFIELD. Mr. Ramey has one more question on the klystron tube.

Mr. MCCONE. Dr. McDaniel told me I did not say that quite right. The actual obligation will be $4,200,000 in 1961, and the dollar expenditure will be $2,200,000 in 1961.

Representative VAN ZANDT. Mr. Chairman, at this point can we place this schedule in the record as to the funding of this project?

Representative HOLIFIELD. Without objection, it will be received.

(The schedule referred to follows:)

CONSTRUCTION PROJECT DATA SHEET—LINEAR ELECTRON ACCELERATOR

This detail represents present planning for this machine and associated support facilities. Definitive design and technological development may necessitate changes at a later date.

Obligations and cost schedules

Fiscal year	Obligations	Cost	Activity
1961	$4,200,000	$2,200,000	A-E design of labs, shops, housings, site development; design studies on klystrons, power components, accelerator proper, instruments; construction initiated on labs, shops, klystron modulators; klystron laboratory completed, tube testing initiated.
1962	30,000,000	20,000,000	Design studies on vacuum components, cooling water system; construction of standard accelerator section, model power components; construction initiated on housings, roads, site development; activation of completed labs and shops.
1963	45,000,000	30,000,000	Design of end station research facilities; tests and revisions of standard accelerator section, power and vacuum components; construction initiated on cooling water system components, controls, and instrumentation; housings and site development completed.
1964	18,000,000	30,000,000	Site and housings activated; initial construction of end station research facilities, accelerator proper, vacuum system, power components; testing and initial construction of controls and instruments; klystron tube procurement initiated.
1965	8,000,000	15,000,000	Construction completed and testing initiated on end station research facilities, accelerator proper, vacuum and water systems, power components, instrumentation.
1966	2,000,000	10,000,000	Activation of end station research facilities; testing completed on accelerator proper, vacuum system, power components, instruments; beam startup.
Total	107,200,000	107,200,000	

Representative HOLIFIELD. Mr. Ramey.

Mr. RAMEY. On the matter of the klystron tubes and taking advantage of the possible know-how of Varian Associates, I think the resolution they passed said something to the effect that they would not make on their own initiative proposals on manufacturing klystrons but that, if the Commission asked them to, they would consider participating, and that they would do so on a no-profit basis. If the Commission just never requested them to participate, one thing that could occur is that maybe you are losing the best outfit in the business to participate in this kind of development activity. That is what the problem of conflict of interest brings up quite a few times.

Has the Commission given any consideration to this other alternative of using them on a no-profit basis on the research and development?

Mr. MCCONE. We have not gone that far in our plans on this, Mr. Ramey. There is a very great deal of competence at Stanford University and in other manufacturers, and there will also be great competence in the architect-engineering firms that are employed by Stanford University and by the Commission. If it appears necessary to go to Varian Associates under their offer of assistance on a non-profit basis, certainly we will do that. However, there are, as you know, a number of people on the Stanford staff who are interested in Varian Associates, either in an ownership position or in a consulting capacity, and therefore we felt that this resolution of the board in which they disqualified themselves from bidding would remove them certainly from our concern, and I would hope from this committee's concern on the question of conflict of interest.

Senator ANDERSON. That is all very well, except that another firm is a licensee from Varian and they would go ahead and bid and pay the royalties to Varian and the Varians would come out in about the same place.

Mr. MCCONE. I don't believe that is the case.

Senator ANDERSON. They do have licensees. Those people are bidders and competitors right along.

Mr. MCCONE. Maybe Dr. Ginzton would come forward and explain the interrelationship of Varian and any other manufacturer.

Senator ANDERSON. I have forgotten the names, but I saw a list at one time of four or five licensees from Varian who are active bidders in this field. Is that not right?

Dr. GINZTON. Senator, it is not true that a license from Varian is required to manufacture a klystron.

Senator ANDERSON. Would you start again. I didn't get whether it is or is not true.

Mr. GINZTON. It is not true.

Senator ANDERSON. There is no firm that is licensed from Varian?

Dr. GINZTON. Let me put it differently.

Senator ANDERSON. No, answer that one and then we will go to another one.

Dr. GINZTON. I would like to answer your question, Senator.

Senator ANDERSON. All right.

Dr. GINZTON. The question is this: Is it necessary for somebody to obtain a license from Varian to make these klystrons.

Senator ANDERSON. Varian and Sperry-Rand and the rest on the patent.

Dr. GINZTON. It is not necessary for any firm in the United States to obtain a license from Varian Associates to make these klystrons.

Representative HOSNER. Varian Associates did not own the patent?

Dr. GINZTON. Varian Associates do not own any portion of the patents involved in this case.

Senator ANDERSON. You mean the matter changed in 30 days?

Dr. GINZTON. Pardon me?

Senator ANDERSON. The matter changed in the last 30 days?

Dr. GINZTON. No, sir. Varian Associates never owned any patents pertinent to the case.

Senator ANDERSON. Do you have to just confine it to that? Most of us understand that Sperry-Rand had something to do with it, and Varian and Stanford University and others. By spreading it off and mentioning one, the answer might be technically true and morally wrong. Has it been necessary for people to get licenses under the original Varian patents in order to manufacture these tubes?

Dr. GINZTON. Yes, sir; that is correct.

Senator ANDERSON. Have they paid royalties to Sperry-Rand, Stanford University, Varian, and other people?

Dr. GINZTON. Yes, sir.

Senator ANDERSON. Therefore, at the time the Stanford accelerator proposal was made, if these tubes had been made there would have been royalty to Sperry-Rand, Varian, Stanford University, and others.

Dr. GINZTON. There are two things pertinent. First of all, the patents which cover the klystron needed for this project have expired in February 1960.

Senator ANDERSON. I said in the last 30 days. If you want to make it 45, I won't argue with you.

Dr. GINZTON. All right. The second thing is that we were discussing up to this point whether Varian Associates would benefit in any way by manufacture of these klystrons. The answer to this question is "No." Varian Associates do not participate as a company in the ownership or control of the patents in any way or form whatever.

Senator ANDERSON. Is that the reason Stanford University said it would waive its royalties. If it had no royalties, why would it waive them?

Dr. GINZTON. That is not quite so simple. The point is that this question has been discussed for months between members of the AEC and your committee. It has been quite often mentioned that the question is really nonexistent because the patents would be expiring in February 1960 long before a klystron could ever come into being. Since there was so much concern about this question the university finally realized under the suggestions of the AEC that it was important to point out as emphatically as it knew how that Stanford had no interest in these royalties and waived its rights. It pointed out again that the problem was nonexistent because the royalties will be zero in any case.

Senator ANDERSON. Do I understand that the university waived something it was not going to get anyhow in order to make somebody feel good?

Dr. GINZTON. Yes, sir.

Senator ANDERSON. That is a new experiment.

Dr. GINZTON. It seemed to be required.

Senator ANDERSON. Required or acquired?

Dr. GINZTON. Senator, I wonder if you are aware of the fact that there are two Varian brothers?

Senator ANDERSON. Yes; I knew there were. Maybe I should say there was a division by death or something of that nature. There were two brothers.

Dr. GINZTON. There is a distinction between Varian Associates and the Varian brothers. Varian Associates as a company has never had any rights to the klystron patents. It is not necessary for Varian Associates to license anybody in the field of klystrons, to make klystrons of this kind.

Senator ANDERSON. We are back in the same groove. Did Varian Associates assign anything to Sperry-Rand at any time?

Dr. GINZTON. No, sir.

Senator ANDERSON. Sperry-Rand took the patents themselves?

Dr. GINZTON. Varian Associates never assigned any patents to Sperry-Rand at any time, but Varian brothers as individuals assigned their rights to Stanford.

Senator ANDERSON. Who owned Varian Associates?

Dr. GINZTON. It is a corporation.

Senator ANDERSON. Did Varian brothers have any interest in it?

Dr. GINZTON. Some.

Senator ANDERSON. Only a fraction?

Dr. GINZTON. Yes; a small fraction. It is a publicly owned corporation. There are about 10,000 shareholders.

Representative HOSMER. The patent rights were disposed of and became owned by these various people before this company known as Varian Associates ever came into existence, is that correct?

Dr. GINZTON. This is quite right.

Representative HOSMER. This Varian Associates is a company which does various kinds of business in the electronic field.

Dr. GINZTON. Yes, sir.

Senator ANDERSON. We had a discussion on this with the Commission. Are you familiar with what the Commission told us, that the patents had run out or anything of that nature? I am not complaining, because I think the Commission has been very helpful in this situation and has been forthright about it. As I understood the situation at the beginning, I heard no discussion about when the patents ran out. Did the Commission notify us as far as you know?

Dr. GINZTON. I am sorry I can't answer.

Mr. MCCONE. I cannot answer that.

Senator ANDERSON. The reason I might raise the question is that last year on August 26, 1959, which is not a full year, when we had this matter under lively discussion, we received this letter:

> DEAR MR. RAMEY: This is in reply to your August 19, 1959, letter requesting information on estimated annual royalties for klystron tubes to be used in the proposed Stanford accelerator. The initial complement of klystrons totals 300, including 60 spares. The royalty payments on 300 klystrons are estimated at $45,000 if Stanford does not waive its share, or $34,875 if Stanford does waive its share of the royalties.

Now you tell me Stanford didn't waive anything because it never had anything to waive. Why do you think General Luedecke tried to mislead us, if he did? Did you try to mislead us?

General LUEDECKE. No, sir.

Senator ANDERSON. You said Stanford was going to get $34,000. He said there was never a chance that Stanford was going to get anything. Where is the foolishness in this? Let me find out what is going on.

General LUEDECKE. No foolishness was intended.

Senator ANDERSON. Then I say this testimony does not agree. We get out on a limb and try to find out what is going on. Stanford comes in and says we will waive. Now we are told that Stanford had nothing to waive, so why waive? We hear that Stanford was never going to get any royalties. You wrote us a letter on August 26, and I will be glad to show it to you, in which you estimated the dollars, how much the royalties were going to be to Stanford. Now I understand that there would be nothing to Stanford. How did you happen to write this letter?

General LUEDECKE. This was the information I had at that time.

Senator ANDERSON. Who did you get it from?

General LUEDECKE. It came from Stanford University.

Senator ANDERSON. You mean that Stanford said it was going to get something that it was not going to get. That it lied to you?

General LUEDECKE. This was my understanding.

Senator ANDERSON. What an awful thing to do. How much can we depend on Stanford University for any information at all now if

what they told you was not true. What was the purpose of telling you?

General LUEDECKE. I will have to trace carefully the origin of these figures.

Senator ANDERSON. I would be happy to have it. All I want to say is that there does not need to be any misunderstanding about this situation. I asked some questions.

Mr. MCCONE. I would like to say that the General Manager in writing you on August 26 reflected the information which we had in our hand on that day gained from a letter addressed to Mr. Kinney of Dr. McDaniel's division on August 21 and signed by Dr. Ginzton. This letter is here in the original and maybe Dr. Ginzton will read it and clear this up.

Senator ANDERSON. Dr. Ginzton is chairman of the board of this organization.

Dr. GINZTON. Of Varian Associates, yes, sir.

Senator ANDERSON. Did you write a letter saying there would be royalties to Stanford University?

Dr. GINZTON. I wrote the letter in my capacity as director of the Microwave Laboratory of Stanford University.

Senator ANDERSON. Whether you did it as director of that or president of the company or chairman of the board, why did you send it to us if it was not so?

Dr. GINZTON. Mr. Anderson, may I read you the letter?

Senator ANDERSON. Yes; I would be happy to have you.

Dr. GINZTON. This was written on August 21, 1959, to Mr. Herbert L. Kinney, Washington, D.C., with proper address:

DEAR HERB: In response to your telephone request we are furnishing to you the breakdown of klystron royalties. The present royalties are payable at the rate of 2.5 percent by all manufacturers to Sperry Gyroscope Co. As estimated in the construction project, we believe 300 klystrons will be needed at an estimated cost of $6,000 each. The total procurement cost of the klystrons would be $1.8 million and therefore the royalty rate would be $45,000. The Stanford University portion of this royalty would be $10,125, as indicated in the charts attached. If Stanford University waives its rights to this portion, the total royalties payable by the project would be $34,875.

It is important to note that the klystrons needed for this project are covered by patent, U.S. issue 22,795, which expires on February 23, 1960. Although Stanford University and Sperry Gyroscope Co. own numerous other patents on klystrons which do not expire until a later date, it is not likely that these will apply to the klystron under discussion. It is virtually certain that the project klystrons will be royalty free and the klystrons are not scheduled to begin until 1½ years after commencement of the project or well after the expiration date of the patent. After all the patents expire in 6 years, it would seem that the future klystrons would be royalty free. I trust this information is sufficient for your purpose.

Signed by Ginzton, Director of the Microwave Laboratory.

Senator ANDERSON. Will you examine the letter General Luedecke sent me and see if all that information is in this letter by any manner of means? Is there anything in that letter which says this will be royalty free?

Mr. MCCONE. No. The letter of August 26 addressed to the committee did not contain the conditional statements in Dr. Ginzton's letter of August 21 for the reason that, in the opinion of our counsel, there was a probability that royalties would be applicable and it was not sufficient for us to make a categoric statement that they would

not be. Therefore, we thought in informing you as to the royalty situation, your committee should know what the full exposure or the full liability for royalties might be. The letter of Dr. Ginzton points out that while the basic patent expires, others would be in existence. His surmise that royalties might not be payable was not sufficiently convincing to our attorneys to make a case to your committee. For that reason the General Manager expressed himself as he did, and I feel he was correct in so doing.

Senator ANDERSON. I think so, too. I want to say to General Luedeke that this was the way to present it, that there was a possibility of royalty. Isn't it true that while the basic patent expires, other patents are still applicable?

Dr. GINZTON. Not to this klystron, sir, no.

Senator ANDERSON. How do we know which klystron is which klystron? How will we know about it? Mr. McCone is shaking his head.

Mr. MCCONE. We will not accept that. As far as the Commission is concerned, we are not prepared to say that royalties will not be paid. We naturally will not pay any that are not absolutely essential. We cannot say as a matter of record that royalties will not be paid.

Senator ANDERSON. Precisely. Here is a man who says there is no possibility of applying, and the Atomic Energy Commission trying to protect the interests of the public says they might apply, and gives that as a warning to the committee. I only say to you, Dr. Ginzton, when can we rely on what is said to us in reference to this situation and when can't we? I think the Atomic Energy Commission, and I have said so repeatedly so there is nothing new about this, has been careful to apprise us of all the facts as soon as they knew them. I commend the Commission for so doing. I only wish we could get the same sort of answer out of Stanford University.

Dr. GINZTON. Senator Anderson, I trust we have been forthright. I think our letters to the Commission, and to you, and to others have tried to emphasize the facts as we know them at Stanford University. This is all we can do to be straightforward about this matter.

Representative HOLIFIELD. Dr. Ginzton, I am trying to clarify this in my own mind. As I understand it, your original 17-year patent right expired in February of this year on the klystron tube. If anyone wanted to build that particular kind of a tube, it could be built without any royalties.

Dr. GINZTON. Yes, sir. That is correct.

Representative HOLIFIELD. There have been some improvements, however, on the original klystron tube. If you wanted an improved, more efficient tube, then there would be a different situation arising regarding patent royalties?

Dr. GINZTON. Stanford University does not own any improvement patent on the klystron.

Representative HOLIFIELD. I understand, but there have been some improvements on the original tube and those improvements have been patented, have they not? It is a common occurrence to have a basic patent and have patents pending for improvements which in effect renew a patent on an improved basis, is that not true?

Dr. GINZTON. Generally speaking this could be true. In this particular instance, I do not think it is true.

Representative HOLIFIELD. In this particular instance you do not think that there have been patent improvements filed on the original klystron patent, or you do not think that Stanford is in line for any of those improved patent royalties?

Dr. GINZTON. I can say this: Sperry Rand Corp., which is the sole sublicensee under the Stanford-controlled patents, has informed Stanford University in writing that henceforth, the date mentioned in February of this year, the Sperry Corp. will not pay any royalties to Stanford on this particular class of tubes.

Representative HOLIFIELD. Have they also informed them that they have an improved tube which if they want to buy there will be patent royalties?

Dr. GINZTON. No, quite the opposite. It merely means that klystrons of the kind we need in specific detail and in general are not subject to patents that we are referring to now.

Representative HOLIFIELD. As far as the Sperry people are concerned.

Dr. GINZTON. Yes.

Representative HOLIFIELD. Are there other licensees, however, who might take a different position?

Dr. GINZTON. We would not be aware of what some third or fourth party might have an opinion on. It is impossible to say what some private individual or some other firm might feel about the matter. We can only speak for the royalties which would be due to the group of people, individuals in the university and others connected with Stanford. We say that no royalties will be payable to Stanford University by virtue of the patents which have been discussed.

Representative HOLIFIELD. If any royalties rights do exist on the part of Stanford, they are waiving those royalties as far as they are concerned.

Dr. GINZTON. Yes, sir.

Representative HOLIFIELD. Sperry Rand has waived as far as they are concerned on the original klystron patent?

Dr. GINZTON. No; that is not right. Sperry has never been approached about this matter. All we say is that Stanford University waives its share of any royalties which might possibly accrue to it should some accident occur in some way that is not explainable or foreseen.

Representative HOSMER. Mr. McCone, does the AEC buy any vacuum tubes?

Mr. MCCONE. We will pay for them.

Representative HOSMER. I mean in your operations now.

Mr. MCCONE. Are we buying any vacuum tubes?

Representative HOSMER. Yes.

Mr. MCCONE. I don't believe so. The contractors do buy them directly. We buy the tubes through contractors.

Representative HOSMER. They are all loaded with patents?

Mr. MCCONE. Undoubtedly, yes.

Representative HOSMER. That royalty there is all part of the price.

Mr. MCCONE. That is correct.

Representative HOSMER. Then there is no difference between vacuum tubes and klystron tubes?

Mr. MCCONE. The issue here is not whether there was going to be some royalties paid. The issue was because there were royalties paid there was a conflict of interest.

Representative HOSMER. That is right. The only question here is a conflict of interest and not patent and royalties.

Mr. MCCONE. I would like to be abundantly clear on this. Stanford's action in waiving their royalty was a satisfactory action from our standpoint. It is in a letter, and it would be reduced to a formal and comprehensive agreement at the proper time. Now, with respect to whether this particular basic patent has expired on February 1960 or not is irrelevant, because we are going to have the best tubes and most improved devices that are available when these klystron tubes are to be purchased.

Representative HOSMER. Even if it did not expire the most it would involve is $15,000.

Mr. MCCONE. If that involves patentable improvements for which there is a royalty, that will be paid. For that reason we do not want to leave this committee with the feeling that there are no royalties on these klystron devices because there very likely might be. Those royalties will not flow to Varian Associates and Stanford will have waived its share of the royalty, if any is due to Stanford.

Representative HOSMER. Which at the most would be the sum of $15,000.

Mr. MCCONE. It is estimated at $10,000 on the basis of the preliminary estimates. It might be even more than that. It might apply to replacements and so forth in the future. This is the reason for the type of letter which we sent to the committee on August 26 of last year.

Representative WESTLAND. I would like to ask Dr. Williams a question.

In your statement, Doctor, you start out by talking about the "fundamental particles."

Dr. WILLIAMS. Yes.

Representative WESTLAND. Is that the end objective?

Dr. WILLIAMS. This a generic name for a group of particles which have different masses than the ones we are familiar with. We call them fundamental particles for the reason that we don't know of anything more fundamental to call them. If we can find a scheme by further investigation how they fit in a master scheme, in the same way that the periodic table of 92 elements was described, then we would call them units or elements or something quite different. At the moment we are loosely talking about the forefront of knowledge as we see it today. This is the furthest we can see today.

Representative WESTLAND. In high energy physics.

Dr. WILLIAMS. It is a very poor name to call it a fundamental particle. What is a fundamental particle? You are asking a key question. I don't know the answer, except to admit that we are somewhat stupid in knowing how to name these things.

Representative WESTLAND. Do you differentiate between this so-called fundamental particle and a strange particle?

Dr. WILLIAMS. No; only in the sense that fundamental particles could include electrons and protons and photons and things with which we have considerable experience and which we feel we understand, also neutrinos and antineutrinos which we have seen and watched our knowledge grow. Over and above that there are these strange particles. You may remember during the hearings last July, Dr. Haworth showed this chart. It gives us the best understanding we can in tabular form of what these strange particles, antiparticles and so on, mean. It is a very complicated question. I hope you might be interested to look back at the hearings and Dr. Haworth's testimony of last July, and perhaps that will clarify to some extent the meaning of this chart. So the ones down here are what we call, for want of a better name, fundamental particles.

Representative WESTLAND. At least for a layman, Doctor, this is not an easy subject.

Dr. WILLIAMS. It is far from an easy subject for a competent scientist, I can assure you, Congressman.

Representative WESTLAND. That is why I asked that some of these questions be answered in words of one syllable. In other words, this is a search into the fundamental composition of matter.

Dr. WILLIAMS. That is an exact way of stating what we are trying to do, to get into the finer grain structure of what matter is made of. Because these particles have different masses, we have to have more energy in the machine to create them. Possibly this is not the top of the table. We will get the strangeness number, greater than plus two or minus two, and require even greater energy. We have prepared, if you would like, a brief table of the kinds of things that have been performed on our various accelerators, like the bevatron or the cosmotron.

If you would like, Mr. Chairman, we can supply that for the record. It is rather technical.

Representative HOLIFIELD. It will be received.

(The information requested is as follows:)

CHARACTERISTICS OF MULTI-BEV PROTON ACCELERATORS

ACCELERATOR	Capability to be Achieved in Fiscal Year	Energy in Bev	Production Capability: Particles per pulse	Pulses per minute	Current in Amps	Anti-Baryons	Hyperons	K^+, K^o Mesons	K^-, $\bar{K}^o$ Mesons	Pi, Mu Mesons	Processes far above Threshold
Cosmotron, BNL	1959	3.2	$8 \cdot 10^{10}$ *	12	$3 \cdot 10^{-9}$	0	x	x	0	x	0
Bevatron, LRL	1959	6.2	$2 \cdot 10^{11}$ *	11	$6 \cdot 10^{-9}$	x	x	x	x	x	0
AGS, BNL	1961	30	$4 \cdot 10^{11}$ **	20	$2 \cdot 10^{-8}$	x	x	x	x	x	#
ZGS, ANL	1963	12	$3 \cdot 10^{12}$ ***	15	$10 \cdot 10^{-8}$	#	#	#	#	#	x
Princeton - Penn	1962	3	$5 \cdot 10^{10}$ ***	1140[a]	$15 \cdot 10^{-8}$	0	#	#	0	#	0
Improved Bevatron, LRL 20 Mev injection	1962	6.2	$7 \cdot 10^{12}$ ***	11	$20 \cdot 10^{-8}$	x	#	#	#	#	0

* Observed values

** Injector limit

*** 1/2 space charge limit

a/ Use of bubble chambers limited by high pulse rate

0 - Very little or no capability

x - Means useful capability but compared with other accelerators limited by injection or energy

\# - A special capability

Representative WESTLAND. I have tried to study this to some extent with my extremely limited knowledge in this field. I gather the thing you propose to do in this linear accelerator cannot be done in any of these other machines you have, the cyclotron or synchrotron or these other machines you are building?

Dr. WILLIAMS. In the 28 to 30 Bev. machine at Brookhaven we don't know what it will produce, because we have not had enough experience with CERN. That is not the only thing the new machine will be used for. By virtue of having an external collimated beam it can interact with matter in a cleaner way so we can see what is going on. If you send a beam into the machine and run it into the target, it will be easier to observe.

Also we will put together in that way more of the fundamental particles so that we see when a sigma hits against a lambda.

Representative WESTLAND. There is not one fundamental particle that you are seeking?

Dr. WILLIAMS. No. There are over 30 that we have seen. The fundamental difference between what we can do with existing machines and the so-called Stanford accelerator is that all the existing machines that get up to this energy are proton machines. There is no electron machine with the characteristics of the Stanford accelerator available. In other words, we believe by building this so-called linear electron accelerator we will be making the next and most important advance in the science of high energy physics.

Representative WESTLAND. This 28 to 30 Bev. that is being built, I think you said it will be ready sometime this year?

Dr. WILLIAMS. In the next month or two.

Representative WESTLAND. You don't anticipate finding these funamental particles or strange particles in that machine?

Dr. WILLIAMS. We do, yes. We may find even stranger ones than are listed down here. I believe that the Stanford electron machine has many more powerful things that can contribute to this general research. Indeed, we said in the statement which I gave earlier that there are five general areas in which one can anticipate further knowledge. The principal one which stands out is the interaction between electrons and nuclei. That is very much simpler than the interaction between protons and nuclei. Growing out of that is the production of some more strange particles. Also the photons and electrons can be used to see the size and shape of nuclei. All of these things are important.

Representative WESTLAND. Which you can find in the linear accelerator or which you do not find in these others?

Dr. WILLIAMS. You would not find it in the big circular accelerator as we know it today.

Representative WESTLAND. What is the difference between an electron and proton machine? What do you hope to find in one that you don't find in the other?

Dr. WILLIAMS. There is a very specific difference between them. In the electron machine one is investigating the interaction of electrons. On this chart you will see the electrons are the lightest of the real particles with any finite mass. Interacting through its electric field with the field of protons ad neutrons in the nucleus, is called an electromagnetic interaction. Because of the nature of the theory we understand that interaction better. If we talk about the interaction of a

proton or neutron with other protons and neutrons in the nucleus, that is a description which we really don't understand fully. So there is quite a different thing between proton and electron machines.

Representative WESTLAND. Even though you might find the same fundamental particles or strange particles in this machine that will be ready in another month, you will be able to see them better in this linear accelerator.

Dr. WILLIAMS. It is only one of the common attributes between the so-called AGS and the Stanford machine. There are many more things also that the Stanford machine can do than just produce more of these particles. It is those things which we want very much to look into and we want to spend most of our effort on those. As the strange particles become more fruitful or we get things we don't see otherwise, then so much to the good.

Representative WESTLAND. I think that is about all I can absorb at this time.

Dr. WILLIAMS. I would be happy some day to talk further with you if you are interested

LINEAR ELECTRON ACCELERATOR

Senator ANDERSON. Dr. Ginzton, in your microwave laboratory, have you a project known as Project M?

Dr. GINZTON. Yes, sir.

Senator ANDERSON. What is that project?

Dr. GINZTON. You mean what the symbol stands for?

Senator ANDERSON. Is it the Stanford accelerator that we have been talking about?

Dr. GINZTON. Yes.

Senator ANDERSON. In your letter to the Atomic Energy Commission, did you refer to Project M?

Dr. GINZTON. I presume we must have numerously.

Senator ANDERSON. Did you list the royalties payable under Project M? I will be glad to let you look at it if you desire. Klystron royalties for Project M.

Dr. GINZTON. Yes, sir.

Senator ANDERSON. Do you show in that total royalty $45,000?

Dr. GINZTON. Yes, sir.

Senator ANDERSON. Do you show a share to Stanford University?

Dr. GINZTON. Yes, sir.

Senator ANDERSON. Is it correct to think then that under the high energy accelerator, whatever the proper name is, that there was no expectation of royalties to Stanford University?

Dr. GINZTON. I don't quite know how to answer you because in the letter to which this diagram is attached we tried to answer the specific question which was asked of us by AEC. The question specifically which we were trying to answer was this: Suppose the royalties did exist, then how much would the royalties be, and how would they be divided.

Senator ANDERSON. Was that the question from the Atomic Energy Commission?

Dr. GINZTON. Yes, sir. This was a telephone question to me by Mr. Kinney who asked this specific question. I said to him then as I said in this letter, we will furnish you the specific information, computed

in a way that will be sensible, but we would like to point out to you as I did in the specific letter you are looking at at the moment, in our opinion this was a hypothetical question which had no real meaning, and to which the answers that we gave in the letter.

Senator ANDERSON. It is pretty hard for me to know what was in the telephone conversation. I just say to you that in response to your telephone request, the letter reads:

> We are furnishing you the breakdown on klystron royalties.

I don't see anything in there that says that is what Alben Barkley used to call a supposititious statement. You were asked about the breakdown of the actual royalties.

Dr. GINZTON. I trust the meaning of that was made clear in subsequent paragraphs of the letter.

Senator ANDERSON. (reading):

> As estimated in the project data sheet we believe 300 klystrons will be needed at an estimated cost of $6,000 each. The total procurement cost of the klystrons would be $1.6 million and therefore the royalty would be $45,000.

Does that say the royalty would be or might be in some supposititious situation that someone might imagine in some subsequent date?

Dr. GINZTON. I don't think I can contribute any more, sir.

Senator ANDERSON. Does this say "would be"? I would be glad to let you refresh your memory.

Dr. GINZTON. I remember the letter.

Senator ANDERSON. It says "would be."

Dr. GINZTON. Yes.

Senator ANDERSON. It does not say it could possibly be or if somebody made a donation in some future date in some circumstances. It says "would be."

Dr. GINZTON. Yes.

Senator ANDERSON. The Stanford University royalty would be $10,500. You recognize the meaning of the term "would be."

Dr. GINZTON. Yes, sir.

Senator ANDERSON. As indicated in chart attached and the chart attached refers to Project M, and you testified that is the Stanford linear accelerator, did you not?

Dr. GINZTON. Yes.

Senator ANDERSON. If Stanford University waives its rights to this portion the total royalty paid by the project would become $34,875. Would that indicate that Stanford might have royalties to waive, if somebody did not know of the telephone conversation?

Dr. GINZTON. I say you are correct. If a third party would read this letter as you are reading it now, I can understand how this letter could be interpreted as you are interpreting it.

Senator ANDERSON. I only say to you that I talked to Mr. McCone about this and I said to him that I did not think either one of us wanted to be involved in a conflict-of-interest case. Therefore, for the protection of both of us, I hoped he would find out about the royalty situation. I think Mr. McCone will admit that was a correct statement of my purposes.

Mr. MCCONE. Yes.

Senator ANDERSON. Mr. McCone subsequently told me that Stanford University was willing to waive its royalties. I thought that was fine. Today for the first time in my life I find a statement by you

as both a representative of Stanford University and chairman of the board of this corporation that there would be no royalties to Stanford because the patents would run out. If there would be no royalties to Stanford the simplest thing to write back was you are talking about a pie that does not exist. We don't have to divide it because there will be no pie to eat. You say the klystrons needed by this project are covered by a patent which expires on February 23, 1960. Although Stanford University and Sperry Gyroscope Co. own numerous other patents on klystron devices which do not expire until a later date, it is not likely that these will apply to the klystron under discussion. Is that a flat statement that they will not?

Dr. GINZTON. The statement you read is not a flat statement; no.

Senator ANDERSON. Are royalties paid on orders delivered or on goods delivered?

Dr. GINZTON. On goods delivered.

Senator ANDERSON. Are you certain?

Dr. GINZTON. Why; yes, sir.

Senator ANDERSON. You state that as chairman of the board?

Dr. GINZTON. Yes, sir.

Senator ANDERSON. Because that is not always the practice, is it?

Dr. GINZTON. Well, I suppose——

Senator ANDERSON. "It is virtually certain therefore that project M klystrons will be royalty free. Delivery of the klystrons needed for this project are not scheduled to begin until 1½ years after the commencement of the project or well beyond the expiration date of the patent in question."

I have not been so worried about it, but the Atomic Energy Commission says they are not willing to accept that statement. You can understand why. The mere statement "It is not likely."

Are you familiar at all with when this business of Varian Associates got to where it was desirable to list it in trading and on the big board?

Dr. GINZTON. I am not sure I know the answer to your question.

Senator ANDERSON. Were you chairman of the board on July 28, 1959?

Dr. GINZTON. I was elected chairman of the board shortly or approximately at that date.

Senator ANDERSON. At that time were Varian Associates listing an application to the New York Stock Exchange?

Dr. GINZTON. In the process of so doing.

Senator ANDERSON. Did they issue a stock dividend in the first part of 1959?

Dr. GINZTON. I can't be sure there of the dates, but I think the answer is yes.

Senator ANDERSON. If I refreshed your memory, would June 1 be the date for the stock dividend, 1959?

Dr. GINZTON. That is approximately right; yes, sir.

Senator ANDERSON. The application to the Securities and Exchange Commission says:

> On June 1, 1959, 1,560,643 shares of the capital stock of the company were issued pursuant to a stock splitup in the nature of 100 percent stock dividend.

How much did that follow the announcement of the Stanford accelerator project?

Dr. GINZTON. The president announced the project, I believe, on May 14.

Senator ANDERSON. Yes. Then, within 2 weeks Varian announced a 100-percent stock dividend.

Dr. GINZTON. Yes, sir; but you realize as well as I do that decisions of this sort to proceed with a stock split are made months in advance of an actual date on which these things are accomplished.

Senator ANDERSON. By what order is it that a corporation has to have months in advance to decide to split its stock?

Dr. GINZTON. To obtain permission from the Corporation Commissioner and go through all the legal steps required takes quite some time. The decision by the Varian board was taken months in advance of that date.

Senator ANDERSON. Let me see if I understand you again. If Varian Associates decided to split the stock and issue a 100-percent stock dividend, it would take months of preparation.

Dr. GINZTON. Yes, sir.

Senator ANDERSON. Could you cite me any corporation law that requires that, because I sit on a board that declares dividends right along, and we don't need months of preparation.

Representative HOSMER. If the gentleman from New Mexico will yield, the California law requires that the permit be obtained from the Corporation Commissioner on any type of stock issue. In my experience, that generally takes anywhere up to 6 months to do. It is preceded by a resolution of the board and in some cases an actual vote of the stockholders. It is a rather lengthy process in California, I can assure you of that.

Senator ANDERSON. It could be. Do you know when the board of directors took the final action?

Dr. GINZTON. I cannot furnish you the specific details or dates. If you are interested, I can supply them.

Senator ANDERSON. Could it be May 14, 1959?

Dr. GINZTON. The answer is no.

Senator ANDERSON. It could not be? You are real sure?

Dr. GINZTON. I am positively sure.

Senator ANDERSON. Did the board of directors hold a meeting on May 14, 1959?

Dr. GINZTON. I can't remember specifically at the moment.

Senator ANDERSON. It says so in their application to the Securities and Exchange Commission.

Dr. GINZTON. I am sorry, I can't remember specific dates. If there are any specific dates you would like to have, we would be glad to furnish them to you. I think the inference from this, I presume, is that in some way Varian Associates was trying to benefit?

Senator ANDERSON. No. I thought they thought the announcement of the building of the Stanford accelerator was a wonderful thing for Varian Associates, didn't they?

Dr. GINZTON. As citizens of the community and as a technically-minded company, yes; of course. But in terms of business, the prospects for the company, the answer is it did not make any difference.

Senator ANDERSON. You are the head of the microwave laboratory?

Dr. GINZTON. Yes, sir.

Senator ANDERSON. That has charge of the project?

Dr. GINZTON. Yes, sir.

Senator ANDERSON. And you are chairman of the board of the corporation?

Dr. GINZTON. Yes, sir.
Senator ANDERSON. From which the tube might have been ordered?
Dr. GINZTON. Not any longer now.
Senator ANDERSON. Not any longer. I have no further questions.
(See app. III for subsequent JCAE-AEC correspondence, p. 489.)

ZERO GRADIENT SYNCHROTRON

Representative HOLIFIELD. Are there any questions? If not, we will turn to the zero gradient synchrotron, a $42 million item, project 57–d–1. A cost breakdown just furnished to the committee differs considerably from that furnished in January. The design was 60 percent complete on February 29, and yet the contingency figure has risen from 5 to 7½ percent. Also, engineering design and inspection costs have risen from $1,807,000 to $6,317,000. Yet the total of $42 million remains unchanged. How do you explain this apparent inconsistency?

Dr. MCDANIEL. The project was originally authorized at $15 million, but no work was ever done on it. In 1958 the authorization was changed to $27 million and work was started on the project in July 1959. At that time the current cost estimate was about $29 million for the base project. The work has proceeded and about $11 million has been committed of the base project. Last November we had a detailed review with the Argonne National Laboratory staff and with all of the high-energy physicists from all over the country at Brookhaven National Laboratory, and we asked each of the managers of the projects to provide the Commission with their best estimates of what future obligational requirements were to make each of these facilities a completed facility—completed in the sense that it was effectively and economically designed. The Argonne National Laboratory reexamined its requirements and estimated that an additional $13 million worth of additional facilities and improvements would be required.

The $13 million estimated at that time included the addition, if you look at the chart, of two external proton areas instead of the one which we have listed on the chart. The $13 million, in addition, would have provided for a fully automatic control device. In reexamining their actual cost experience, and in factoring in the additional requirements of the two proton areas, it was originally thought that a $42 million obligation would take care of the base project and the additional facilities which are discussed in the sheets. A thorough examination in recent weeks has indicated that it is not possible within the $42 million to provide two proton areas at the ZGS and the fully automatic control device. We have accordingly reprogramed the construction, and within the $42 million we must eliminate one of the proton areas and the fully automatic control device. A complete reestimate of the cost then provides the estimates which you read out.

Representative HOLIFIELD. We have some other questions on this point, and also some questions on the other points involved here, but we are going to submit them to you in writing. The reason is that we are going to have to give this room up in 5 minutes to another organization. So we will submit some additional detailed questions on this and some other points to you in writing. The staff will submit them, and we hope you will give us an answer to them.

(The information referred to follows:)

APRIL 6, 1960.

Gen. A. R. LUEDECKE,
General Manager,
U.S. Atomic Energy Commission,
Washington, D.C.

DEAR GENERAL LUEDECKE: Enclosed, pursuant to Congressman Holifield's directions at the close of the meeting this afternoon, are additional questions on certain high energy physics projects proposed for inclusion in the authorization bill. It is requested that the Commission respond to these questions by next Monday, April 11, 1960, if possible.

Sincerely yours,

JAMES T. RAMEY, *Executive Director.*

ATOMIC ENERGY COMMISSION,
Washington, D.C., April 14, 1960.

Mr. JAMES T. RAMEY,
Executive Director,
Joint Committee on Atomic Energy,
Congress of the United States.

DEAR MR. RAMEY: Your letter of April 6, 1960, enclosed additional questions on certain high energy physics projects proposed for inclusion in the fiscal year 1961 authorization bill. Answers to these questions are furnished in the enclosure hereto.

Sincerely yours,

A. R. LUEDECKE, *General Manager.*

ANSWERS TO QUESTIONS RELATING TO PROJECT 61-f-2, THE PRINCETON-PENNSYLVANIA ACCELERATOR ADDITION, $10,820,000

According to the backup data, the office space is needed by July 1960 but the new wing won't be ready until September 1961.

Question 1. Why wasn't this requested last year?

Answer. The additional wing was not requested last year because it was not yet clear that persons carrying out experiments from outside the project would stay at the site as long as now seems necessary. Thus, more space has become necessary to accommodate scientists using the accelerator.

Question 2. What will the total investment at Princeton be, including this project?

Answer. The total plant investment at Princeton, including project 61-f-2, will be approximately $36 million, including the investment in plant facilities for the controlled thermonuclear program.

Question 3. Are any other major additions or modifications forseen for the future?

Answer. In addition to the project authorization currently being requested it is possible that storage rings may be required at some future date. (See question 7.) Some laboratory space in other buildings is now being made available for an initial nuclear chemistry program that will be started when the accelerator comes into operation. Depending on programmatic developments, a nuclear chemistry facilities may also be required at some future date.

Question. 4. Why is 17½ percent of construction costs needed for engineering, design, and inspection and 18½ percent for contingencies? These two items total over $3 million out of the total of $10,820,000 for this project. Even the Stanford project has only 13 percent for engineering, design, and inspection and 15 percent contingencies.

Answer. The engineering allowance of 17½ percent will provide for the design of additional buildings and related facilities costing about $5 million, the major item being the external beamroom, and for miscellaneous equipment estimated at $2.7 million. Our experience is that the engineering for special purpose buildings requiring extensive mechanical services will range from 12 to 18 percent, and will run higher for certain equipment items such as shielding, magnets, etc. Consequently, 17½ percent has been used as an average engineering cost. The 18½ percent allowed for contingencies is based on experience on other accelerator projects; a high percentage is necessary because of the uncertainties associated with accelerator projects.

The Princeton-Penn project is about one-tenth the size of the Stanford project. In the case of large projects, experience shows that the percentage allowance for engineering decreases somewhat as the size increases. This is partly due to repetitive features found in large projects. For example, structural design of the two 10,000-foot structures for Stanford would cost about the same regardless of length, i.e., whether the length was 500 or 10,000 feet. The 15-percent allowance for contingencies similarly is based on experience which indicates some decrease in percentage with increasing size.

Question 5. We understand that there is a delay in completion of the accelerator construction. What is the present estimated completion date?

Answer. It is presently estimated that all components of the accelerator will be in place by the spring of 1961. This will be followed by a period of obtaining an accelerated beam and generally optimizing the machine operation. The duration of this phase cannot be well predicted but past experience has shown that this period is likely to extend from several months to possibly as much as 6 months. We expect that the machine will be ready for research work about July 1961.

Question 6. What is the reason for the delay?

Answer. The delay is largely attributable to two factors:

(*a*) Longer development time required for various components than was originally anticipated. Specifically, difficulties have been encountered in the design of the magnet yoke, the RF accelerating system and the vacuum chamber.

(*b*) Delay in delivery of components by the various fabricators.

Question 7. When will you request authorization for the beam storage rings for the colliding beam experiments which we understand are planned?

Answer. The future prospects for storage rings for colliding beam experiments at Princeton are still problematical. The scientific justification for such an addition to the facility remains to be demonstrated since—

(*a*) the feasibility of carrying out any colliding beam experiments has yet to be demonstrated. An experiment is being set up for electrons at Stanford University, and the MURA electron model is operating in the clashing beam mode. Results from these two studies should be very helpful in determining some of the experimental difficulties to be encountered in such experiments.

(*b*) even assuming the feasibility of doing such experiments, the results might be obtained more easily using more conventional techniques. For example, colliding beams at Princeton would yield 6 billion electron volts in the center of mass system, which is the same as would be obtained in a conventional manner with the Brookhaven AGS. Princeton has indicated that one possibility for the rings would be to add an acceleration system to raise the energy to 6 billion electron volts in each ring. Even if feasible, the storage rings would then represent a major installation, considerably larger than the original accelerator. Accordingly, location of the storage rings at another site with a higher energy accelerator might be more satisfactory. For these reasons, the storage rings must be considered as only a possibility for the future, one which is not at all likely at least until fiscal year 1966.

Question 8. Do the present requested facility changes take this into account in regard to long-range planning?

Answer. The present facility changes do not conflict with the possibility of adding storage rings, but there is actually little relationship with the present additions. The accelerator has three different ports from which external beams might be extracted. One of these will be used by the requested external beam facilities and either of the others could be used for the storage rings.

ANSWERS TO QUESTIONS RELATING TO PROJECT 61–f–5, ACCELERATOR IMPROVEMENTS, LAWRENCE RADIATION LABORATORY, AND PROJECT 61–f–6, MAJOR BEVATRON IMPROVEMENTS, LAWRENCE RADIATION LABORATORY

The backup data states the architect-engineering work will be done by the Laboratory, and possible construction as well. The same statements pertain to the major bevatron improvements project for $9,600,000.

Question 1. Is the Laboratory equipped to do this work?

Question 2. Isn't the work of the type normally performed under contract?

Question 3. Are the other laboratories also equipped to handle this type of work?

The following statement is in answer to questions 1, 2, and 3 above:

Answer. None of the construction work included under either data sheet is of the type ordinarily referred to as "construction," except for the concrete shielding referred to in paragraph 9A of the data sheet for project 61–f–6. The modification of accelerators, their appurtenances, and similar experimental facilities, is a highly specialized activity. The Laboratory, with its extensive experience in accelerators, has developed a staff with substantial capability in this particular activity. It is not feasible to contract for outside engineering design because design firms in private practice have no experience in this work.

Calculations for the thickness of the concrete shielding will be made by Lawrence Radiation Laboratory. It has not yet been decided whether the A–E work for this shielding will be performed by the Laboratory's engineers or by a private firm. It is expected that competitive bids will be taken for construction of the shielding and the incidental foundation work.

In general, AEC's laboratories follow the above practice on the machines proper. The design and assembly of accelerators and similar equipment is so highly specialized that the work must, of necessity, be performed by physicists and engineers on the Laboratory staff. These machines are unique and have no counterparts outside the laboratories. Component parts and equipment items are purchased from commercial sources insofar as is practicable.

Question 4. Why are rectifiers and a generator funded out of construction funds, and the magnet is from operating funds?

Answer. The Commission has developed criteria which provide the basis for distinguishing between those types of equipment which are chargeable to the "Operating expenses" appropriation and the types of equipment which are chargeable to the "Plant acquisition and construction" appropriation. Briefly, the distinction is drawn along the following lines:

Equipment which is of a permanent or fixed nature and which has continuing utility throughout the life of the facility to which it is attached (such as the rectifiers and generators) is chargeable to the "Plant acquisition and construction" appropriation. On the other hand, equipment such as beam focusing and beam analyzing magnets, which are used in conjunction with an accelerator for the accomplishment of specific experimental programs, are not considered to be an integral part of the machine itself and therefore are appropriately chargeable to the category of the "Operating expense" budget entitled "Equipment not included in construction." When the modifications to the 184-inch cyclotron are completed, the analyzing magnet will not be installed as a permanent improvement to the machine. It is simply a piece of experimental apparatus required for the conduct of experiments with the machine.

Question 5. What beam current will be obtained by this requested improvement for the HILAC and what technical necessity is there for it?

Answer. The research group presently utilizing the HILAC has attained beam current of 3 to 5 microamps (direct current). The improvements requested for fiscal year 1961 would increase this intensity to the region of 15 to 20 microamps (direct current). Since the intensity of the beam current determines the number of particles available to the target per unit of time, it becomes apparent that the effectiveness of the machine is directly proportional to the intensity of its beam. Increasing beam intensity by a factor of approximately 5 will make possible production and detection of short-lived isotopes which heretofore have been beyond the capabilities of the HILAC with its present beam intensity. Of particular interest to the experimenters are those elements found beyond the number 100 in the periodic chart of the atoms. This group, known generally as the transuranium elements, constitute one of the newest frontiers of basic science, and is an area in which the Lawrence Radiation Laboratory excels. The experimentation directed toward identifying the characteristics of these elements require that the beam current of the HILAC be increased as requested.

Bevatron project (LRL project 61–f–6)

Question 1. Didn't the Research Division originally ask for $11 million?

Question 2. What has been left out?

Answer. On the basis of the original estimate prepared by LRL, the Research Division did request $11 million. However, this estimate was lacking in a detailed breakdown of costs beyond the first year of work. A subsequent review of the project by LRL showed that the original estimate was high and could be reduced to a new total of $9.6 million. No items have been omitted in the revised estimate.

ANSWERS TO QUESTIONS RELATING TO PROJECT 57–d–1 ZERO GRADIENT SYNCHROTRON, ARGONNE NATIONAL LABORATORY, $42 MILLION

The cost breakdown just furnished the committee differs considerably from that furnished in January. Design was 60 percent complete on February 29 and yet the contingency figure has risen from 5 to 7½ percent. Also, engineering, design, and inspection costs have risen from $1,807,000 to $6,317,000. Yet the total of $42 million remains unchanged.

Question 1. How do you explain this apparent inconsistency?

Answer. The cost breakdown originally supplied was based on a project review conducted in December 1959. Additional project reviews conducted in February and March 1960 made it necessary to revise these figures somewhat. The elimination of one of the two proton areas originally envisioned, and the resulting reduced need for power supplied, resulted in a redistribution of the cost breakdown, including provision for a more realistic contingency figure of 7½ percent. The main reason for the apparent increase in engineering costs stems from the fact that what now appears as "Argonne National Laboratory engineering" was incorporated into the costs for the accelerator proper in the original breakdown submitted last January. The earlier engineering figure which would be comparable to the $6,317,000 now shown is $5,291,000 consisting of $1,807,000 for buildings and structures, etc., and $3,484,000 for Argonne National Laboratory engineering for the accelerator proper.

Question 2. When will you know whether to recommend adding the other beam and the automatic control room?

Answer. As Mr. McCone stated at the hearings on April 5, 1960, it is the intention of the AEC to conduct an exhaustive review of the need at Argonne National Laboratory for the additional proton beam area and beam programer. Only after this review has been completed will the AEC be able to state categorically whether or not it will ask for these additional items and, if so, at what date.

Question 3. How large is the bubble chamber at Argonne which you propose to start fabricating in fiscal year 1961? (Costs are of interest here.)

Answer. The present plans for a large bubble chamber at Argonne are to construct a 72-inch liquid hydrogen bubble chamber, at a cost of approximately $2 million. The exact size of the chamber, however, is not yet firm; final definite design is expected to be made this fall and at that time the size will be frozen. Recent indications are that a larger chamber may be desirable, but further study and perhaps some development will be required before the optimum size will be decided. If it is found to be technically feasible to construct a substantially larger chamber and if sufficiently compelling scientific reasons exist to justify the costs, additional funds to cover the increase in size may be requested in the budget for fiscal year 1963. The first bubble chamber at the ZGS will be a medium size chamber (25 inches) which should be available for use when the ZGS begins operation. This chamber which will cost about $650,000, is now being designed by a group of physicists from Wisconsin, Purdue, and Michigan State, working at Madison. They will obtain support from the engineering and shop facilities at MURA for the detailed design of the various components and for the fabrication of many items. The chamber will be tested at MURA and will then be transported to Argonne National Laboratory, to become part of the high energy experimental facilities there.

Question 4. Do they plan to use other high energy particle detectors and associated experimental equipment? Are these items in the cost estimate for the project?

Answer. The high energy physics group at Argonne National Laboratory plans to utilize the most effective techniques available at the time the ZGS comes into operation. For example, they are just initiating a group to begin the development of scintillation chambers for experimental use. These chambers are among the latest detection instruments. They will also use other conventional methods such as nuclear emulsions and counters of all types.

These items will be covered in the operating expenses appropriation and are not a part of the ZGS project.

Question 5. Is this bubble chamber building being designed to adequately cope with hydrogen hazards involved? (Such things as slanted roofing, spark-proof ventilation, etc.)

Answer. Hydrogen hazards are being carefully considered, and the buildings will be designed with this in mind.

Question 6. Does the project cost estimate include the cost of the cryogenics facility mentioned in the project data sheet?

Answer. Yes. However, this is only a storage facility. At the request of the AEC, Argonne National Laboratory investigated sources of liquid hydrogen and found that Argonne National Laboratory could purchase liquid hydrogen from commercial sources at less cost than if it were manufactured by Argonne National Laboratory at the site.

Representative HOLIFIELD. We won't have any meeting in the morning, and tomorrow afternoon at 2 o'clock in this room we will have testimony from the Budget Bureau on the remote site power projects. I assume that some of the Commission will want to be heard and also the representatives of the Army and the Navy.

Mr. FLOBERG. We will see that the services are informed, Mr. Chairman.

Representative HOLIFIELD. That will complete the high-energy physics part of the hearing.

Dr. MCDANIEL. Thank you, Mr. Chairman.

(See app. IV for tentative construction and operating costs of high energy accelerators, p. 491.)

(Thereupon, at 4:30 p.m., Wednesday, April 6, 1960, a recess was taken until Thursday, April 7, 1960, at 2 p.m.)

AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1961

THURSDAY, APRIL 7, 1960

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON LEGISLATION,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D.C.

The subcommittee met, pursuant to recess, at 2 p.m., in room P–63, the Capitol, Hon. Chet Holifield, chairman of the subcommittee, presiding.

Present: Representative Holifield, Price, Aspinall, Van Zandt, and Hosmer; Senators Anderson and Jackson.

Also present: James T. Ramey, executive director; John T. Conway, assistant director; David R. Toll, staff counsel; George F. Murphy, professional staff member; Edward J. Bauser, technical adviser; and Bernard V. Dvoskin, GAO consultant.

Representative HOLIFIELD. The subcommittee will be in order.

The Subcommittee on Legislation of the Joint Committee on Atomic Energy is meeting this afternoon to continue hearings on S. 3084 and H.R. 10656, bills to authorize appropriations for the AEC for fiscal year 1961. This afternoon our subject is possible power reactors for installation at remote sites, including the Antarctic. We have invited representatives of the Bureau of the Budget, AEC, and the Department of Defense.

Following the hearings on March 11, 1960, on this subject, Senator Anderson and I sent letters to Mr. Stans, Director of the Bureau of the Budget, Mr. McCone, Chairman of the AEC, and Mr. Gates, Secretary of Defense. In these letters, we stated that "the stumbling block appears to be the initial capital funds required for the nuclear plant, although the lower operating costs more than compensate for this outlay over the useful life of the plant." We asked the various agencies concerned to consider some method of joint financing whereby the Department of Defense might pay capital costs comparable to a conventional plant, and AEC provide the incremental capital costs, or some similar arrangement.

The Department of Defense reply, by letter dated March 31, 1960, from Under Secretary Douglas, indicated that several possibilities of joint financing had been proposed by DOD.

By letter dated March 30, 1960, Stans replied that he believed that the plants "should be funded in full by the Department of Defense." Therefore, we do not seem to be making much progress since the Department of Defense is for the most part unable to put up the entire capital costs, without AEC participation. We have invited the agencies here, including the Deputy Director of the Bureau of the Budget, to discuss this matter further.

The first witness this afternoon will be Mr. Elmer B. Staats, Deputy Director of the Bureau of the Budget. We are glad to have you with us, Mr. Staats. Will you please come forward to the witness stand.

The chairman might state that the Director of the Budget, Mr. Stans, was invited to appear, and because of pressing duties, he phoned me yesterday and requested that his Deputy Director, Mr. Staats, be here to make a statement for him and on behalf of the official position of the Budget Bureau.

Mr. Staats, you have a prepared statement. You may proceed.

STATEMENT OF ELMER B. STAATS, DEPUTY DIRECTOR, BUREAU OF THE BUDGET

Mr. STAATS. Mr. Chairman, I am glad to have the opportunity to meet this afternoon with the committee to discuss, as you have mentioned in your introductory remarks, the letter which we sent to the committee on the 30th of March on the subject of financing nuclear military powerplants at remote sites. I appreciate the committee's consideration in enabling us to be here this afternoon.

I would like to say at the outset that we in the Bureau fully recognize the potential of nuclear power in meeting the needs of the military services at remote locations. The Bureau letter of March 30 stated as follows:

> We agree that, in deciding whether to build a nuclear or conventionally fueled powerplant at a given military location, the operating costs over the useful life of the plant should be weighed as carefully as the capital costs.

Thus there is no disagreement between the Bureau and the Joint Committee on the point that capital costs in and of themselves should not be a deterrent to building nuclear powerplants.

It is not my purpose today to discuss the requirement for or advantages of atomic power at specific military sites. The only question dealt with in our letter of March 30 and to which I intend to address my testimony is the question of which agency should most appropriately budget for construction of proven atomic powerplants at military sites. In brief, the position of the Bureau is stated in our letter as follows:

> For effective management the responsibility of budgeting for an item should lie with the agency which needs and uses the item. On this basis, we believe that valid power requirements at military sites which can be met to advantage by atomic plants should be funded in full by the Department of Defense.

I would like to make a few additional comments this afternoon which bear upon our position.

The plants under discussion would be proven nuclear plants rather than prototypes of new reactor concepts. As the Kaiser Engineering study stated the reactors selected were based upon "existing reactor designs," which are defined as "designs of plants which have been or are being built, or upon which firm price quotations have been or are being made."

As your letter of March 15 recognizes, the Bureau of the Budget has not recommended against any specific request from Defense for construction of a nuclear powerplant in the Defense budget. Construction of two nuclear powerplants have already been fully funded by the

military services, and others can be expected as requirements develop and as reactor technology progresses. Since Defense has recognized the need for and advantages of nuclear power to the extent of being willing to finance the higher capital costs for the two plants, we know of no reason why Defense should not continue to fund the full construction cost of future reactors which studies might show to be economically and logistically desirable.

I do not believe that the assumption of capital cost by AEC would have the result intended by the committee, i.e., encouraging the military services to recognize and assess adequately the unique advantages of nuclear power in a number of military situations. On the contrary, it would have the effect of increasing the reliance of the military services on the AEC budget for an indefinite period of time. This is true because capital costs of small nucelar plants, even after they are clearly economic over their useful life, are almost certain to remain higher for some time than those for conventional plants. Thus, the Department of Defense would still have to face the difficult period of "withdrawal" of AEC assistance, or, alternatively, we would have to build into the AEC budget a long-term program of construction subsidy to the military services.

The division of budgetary responsibility between Defense and the AEC which I am supporting this afternoon is not new, and will not retard the application of nuclear power to military situations. It is generally accepted as a sound principle of management and budgeting. Moreover, it is the same pattern which has been worked out and applied by mutual agreement between AEC and Defense for many years in the development and construction of nuclear naval ships and nuclear aircraft as well as mobile and portable land powerplants.

Under these mutual agreements, AEC develops new types of military reactors and builds prototypes of these new reactors. Defense has agreed to fund the complete cost of applications, such as nuclear ships, aircraft, and other mobile reactors. The fact that the capital costs of these applications would be higher than conventionally fueled items did not bear on the nature of the agreed funding responsibilities. The Joint Committee was informed of the nature of these arrangements in a letter from the AEC dated May 4, 1954. These arrangements are still in effect.

Construction and operating experience with remote military reactors would be of benefit to the AEC. But this experience is certainly no greater than that from the construction and operation of naval ships and does not in and of itself support joint financing. The agreements mentioned above provide that operating and construction data would be made available to AEC from plants fully funded by Defense.

This concludes my formal statement. Mr. Chairman, I would be happy to answer any questions that the committee may have.

Representative HOLIFIELD. At this point, unless there is objection, I would like to insert in the record a series of letters between Chairman Anderson and myself and the Director of the Budget, and the Defense Department and Atomic Energy Commission, which bear on this particular subject.

(The documents referred to follow:)

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
March 15, 1960.

Hon. MAURICE H. STANS,
Director, Bureau of the Budget,
Washington, D.C.

DEAR MR. STANS: Enclosed for your information are copies of letters dated March 15, 1960, to Hon. Thomas S. Gates, Secretary of Defense, and Hon. John A. McCone, Chairman of the Atomic Energy Commission, concerning the possible use of nuclear reactors to produce electric power at remote sites operated by the military.

From testimony and reports we have to date it appears that it would be economic for the Government to build atomic powerplants at some of these locations, as well as enhance our national prestige. The stumbling block appears to be the initial capital funds required for the nuclear plant, although the lower operating costs more than compensate for this outlay over the useful life of the plant.

I hope you will cooperate with the Department of Defense and the Atomic Energy Commission in developing methods which will result in real economy in our Government expenditures for these projects.

Sincerely yours,

CHET HOLIFIELD,
Chairman, Subcommittee on Legislation.
CLINTON P. ANDERSON,
Chairman.

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D.C., March 30, 1960.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
U.S. Senate, Washington, D.C.

MY DEAR MR. CHAIRMAN: This will acknowledge the letter from you and Congressman Holifield of March 15, 1960, concerning construction of power reactors at remote military sites and enclosing letters on this subject to the Secretary of Defense and the Chairman of the Atomic Energy Commission.

We are reviewing with the Department of Defense and the AEC studies of electric power requirements at a number of military sites and the possible economic and logistic advantages of using atomic powerplants at such sites. Results of such studies will be reported to your committee.

For effective management, the responsibility of budgeting for an item should lie with the agency which needs and uses the item. On this basis, we believe that valid power requirements at military sites which can be met to advantage by atomic plants should be funded in full by the Department of Defense. We agree that, in deciding whether to build a nuclear or conventionally fueled powerplant at a given military location, the operating costs over the useful life of the plant should be weighed as carefully as the capital costs.

The alternative funding approaches cited in your letter to Secretary Gates should not, therefore, apply to the financing of defense requirements. These alternatives, it is true, have been used or considered in connection with the Commission's cooperative reactor demonstration program, but this program has as its objective the promotion of civilian uses of atomic energy through assistance to non-Federal parties in reactor construction. It would appear unsound and unnecessary to use AEC appropriations in the future to provide similar capital assistance to the Department of Defense in meeting its operating power requirements.

The Department of Defense has already provided the full amount of funds for construction of two nuclear powerplants—one at Fort Greely, Alaska, and a second at Camp Century, Greenland. This approach is also used by the Navy, where construction costs of nuclear-powered ships are higher than those for conventional ships. The same pattern, whereby AEC does the research and

development and builds developmental prototypes, and Navy funds the full capital costs of nuclear-powered ships, would appear to be appropriate in the case of power reactors at remote military sites.

Moreover, in the future it can be expected that the extensive military and civilian reactor development programs underway in the AEC will act to reduce capital and fuel costs for nuclear powerplants and increase their attractiveness for military situations.

Sincerely yours,

MAURICE H. STANS, *Director.*

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
March 15, 1960.

Hon. THOMAS S. GATES, Jr.,
Secretary of Defense,
Washington, D.C.

DEAR MR. SECRETARY: The Subcommittee on Legislation of the Joint Committee on Atomic Energy held hearings from March 8 to 11, 1960, to consider S. 3084 and H.R. 10656, bills to authorize appropriations for the Atomic Energy Commission for fiscal year 1961. During the hearing on March 11, testimony was received from representatives of the Army, the Navy, and the Atomic Energy Commission concerning possible construction of nuclear reactors to furnish electric power at remote sites, particularly Okinawa, Guam, and the Antarctic.

Representatives of the Department of Defense testified that they had not recommended construction of power reactors at such sites because of financial considerations, due to the higher initial costs of constructing a power reactor as compared to a conventional powerplant.

We believe that construction of power reactors at such sites would be economic over the useful life of the plants by reducing operating costs (especially in the Antarctic), would advance the art of reactor technology, would enhance the prestige of the United States, and would be in the national interest. We request therefore that the Department of Defense, in cooperation with AEC and the Budget Bureau, develop a system of financing atomic power plants at remote locations which will not penalize the military services in the provision of capital funds and at the same time permit going forward with atomic power plants which are justified for the above reasons. Among the methods which appear promising are the following:

1. An arrangement whereby the Department might furnish funds up to the cost of a conventional powerplant, and incremental funds would be made available by the AEC. Such an arrangement would result in subsequent savings to the Department, and the AEC funds could be justified by the advance in power reactor technology which would be achieved.

2. An arrangement similar to the AEC "second round" power demonstration program, whereby AEC finances the reactor portion of the plant and the utility (or DOD) finances the electric generating equipment.

3. An arrangement similar to that provided for the process heat reactor in Public Law 86–50 which provided somewhat greater flexibility in non-Federal participation.

We would appreciate it if you would review the requirements of the Department of Defense at such sites, particularly with respect to the fiscal year 1961 program, and forward to us your comments by April 1, 1960. The subcommittee and the Joint Committee intend to pursue this subject more thoroughly at the hearings scheduled for April 5–7, 1960.

We are sending copies of this letter to AEC Chairman John A. McCone and Budget Bureau Director Maurice Stans. We are enclosing for your information copies of the letters which we are sending to them.

Sincerely yours,

CHET HOLIFIELD,
Chairman, Subcommittee on Legislation.
CLINTON P. ANDERSON,
Chairman.

THE SECRETARY OF DEFENSE,
Washington, March 31, 1960.

HON. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR MR. CHAIRMAN: I have your and Congressman Holifield's joint letter of March 15, 1960, concerning possible funding arrangements and requirements for nuclear power reactors for remote sites. I agree that construction of reactors at certain remote sites would be economically advantageous over the useful life of the plant, would advance the art of reactor technology, enhance the prestige of the United States and, overall, be in the national interest. My staff has had preliminary discussions with representatives of the Atomic Energy Commission and the Bureau of the Budget, and we will make every attempt to establish a funding system that will be satisfactory for the individual reactors or the program as a whole.

The most promising reactor projects have been reviewed and are summarized as follows:

(*a*) *Okinawa*

A total of 80,000 kilowatts in new generating capacity will be required for Okinawa during 1963. Funds totaling $22.7 million have been authorized to the Army with which to meet this requirement. The Army plans to proceed with construction of 40,000 kilowatts in conventional capacity to be on the line early in 1963. I support the proposed construction of the remaining 40,000 kilowatts as nuclear capacity to be on the line as soon thereafter as an orderly design and constructon schedule will permit. Current estimates indicate that such a combined nuclear conventional plant would cost approximately $39.9 million, requiring additional authorization and funding in the amount of $17.2 million not now available.

A problem relating to consumer rates for power exists in the case of Okinawa. Under current U.S. policy, the High Comissioner, Ryukuyan Islands, must sell power to local consumers at the lowest possible rate in order to foster the local economy. Thus, any arrangement to include nuclear capacity in the power need on Okinawa should provide that power rates to local consumers be no higher than if conventional capacity were used throughout. This might be effected by providing that excess capital cost resulting from the installation of nuclear capacity be excluded from computation of consumer rates for power from the combined nuclear conventional generating system.

(*b*) *Guam*

By letter dated July 31, 1959, the Department of Defense proposed that the Atomic Energy Commission participate with the Department of the Navy for jointly financing a 20-MWe nuclear powerplant for Guam. It was proposed that "the Department of the Navy would fund for that portion of the cost of the plant which corresponds to estimates for construction of a complete conventional plant of this size on Guam. The Atomic Energy Commission would furnish the additional funds required to provide a nuclear powerplant. The Commission would design, construct, and install the plant on Guam. The Commission would have no continuing fiscal responsibility for the plant, since the Navy would pay all operating costs." Although this proposal was subsequently withdrawn because of the inability of the Navy to fund its share of the program in fiscal year 1961, it was reaffirmed at the March 11 hearings that the Navy intends to fund for the project in fiscal year 1962. The basis for the joint funding of this project, as outlined above, is still valid.

(*c*) *Antarctica*

The estimated power requirements are as follows:

McMurdo Sound Station	3.0 megawatt electric operating by March 1963.
	4.5 megawatt electric operating by March 1965.
Byrd Station	0.8 megawatt electric operating by February 1964.
Pole Station	0.5 megawatt electric operating by February 1963.

In view of the Commission's stated interest to participate with the Department of Defense in joint programs in meeting power requirements at remote

installations, the Department of the Navy has proposed that the Commission undertake the development and procurement of the appropriate nuclear powerplants, specifically for use at these three Antarctic stations. The Navy will agree to transport, install, and operate these plants. I have requested the Atomic Energy Commission to support the Navy's request.

(*d*) *Thule*

When the Air Force began preliminary design of the ballistic missile early warning system (BMEWS) the possibility of using nuclear power to generate electrical energy was given detailed study. However, the time schedule imposed upon BMEWS did not allow for the construction of a nuclear plant for initial operation. Therefore, the YFP–10 ship-mounted powerplant was procured on loan from the Navy to provide the needed generating capacity at an early date.

The Air Force again gave consideration to providing a nuclear powerplant for BMEWS in both the fiscal year 1959 and the fiscal year 1960 military construction programs, but because of other priority items was unable to fund for the project. The Air Force now proposes to participate with the Commission for the execution of this project on the following basis:

1. The Air Force will budget for funds in fiscal year 1962 for procuring and installing the conventional components of the plant (approximately $12.5 million).

2. The Atomic Energy Commission will budget for funds in fiscal year 1962 for the development, procurement, and installation of the nuclear components of the plant (approximately $12.5 million).

3. The Atomic Energy Commission will act as executive agent to supervise design, construction, and initial test operation.

(*e*) *General*

In addition to the specific sites discussed above, the military departments have other sites at which nuclear power might offer tangible advantages. Those are at Inchon, Korea, where a 10,000-kilowatt floating plant has been considered, and Asmara, Eritrea, where a 5-megawatt of power will be required. Another possibility is a strategic reserve, 20,000 kilowatts, Atlantic Ocean floating plant for the Navy.

I hope the above information meets your immediate needs. I will ask General Loper to keep you informed of further developments in relation to this subject.

Sincerely yours,

JAMES H. DOUGLAS.

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
March 15, 1960.

Hon. JOHN A. MCCONE,
Chairman, U.S. Atomic Energy Commission,
Washington, D.C.

DEAR MR. MCCONE: Enclosed for your information is a copy of a letter which we are writing to the Honorable Thomas S. Gates, Secretary of Defense, concerning the possible use of nuclear reactors to produce electric power at remote military sites. Also enclosed is a copy of a letter to the Director of the Budget Bureau. We hope that the Department of Defense and the Atomic Energy Commission with the assistance of the Budget Bureau will give serious consideration to the possibility of joint financing of such projects, both in connection with the fiscal year 1961 program and subsequent years.

We would appreciate it if you would review this matter and forward to us your comments by April 1, 1960, in order that we may discuss this matter further during the hearings scheduled for April 5–7, 1960.

Sincerely yours,

CHET HOLIFIELD,
Chairman, Subcommittee on Legislation.
CLINTON P. ANDERSON, *Chairman.*

Representative HOLIFIELD. Mr. Staats, as I understand it, you are here representing the Director of the Budget and your statement is the official position of the Budget Bureau.

Mr. STAATS. That is correct.

Representative HOLIFIELD. You are authorized to answer questions on behalf of the Bureau of the Budget?

Mr. STAATS. That is right, sir.

Representative HOLIFIELD. We have had quite a bit of testimony before the committee on these reactors for remote military installations. They are pretty convincing as to their economics. It is also true that the annual budget would be greater if these capital investments were funded by the Department of Defense at this time, rather than the amount which they have asked for in their budget for maintenance and operation of the conventional plants which now exist at these places. As a result of this differential and because of the pressure on the Department of Defense for other projects of higher priority, the using agencies are put to a higher operating expense annually and a greater total expense over a period of years as the result of their being almost forced by priority decisions in their own budgets to continue what looks to this committee like a very wasteful annual procedure in the operation of powerplants at these remote installations.

For instance, on the McMurdo Sound project, the savings that we have over a period of 20 years between a nuclear plan and a conventional plant amounts to $21,500,000. The Pole Station, over the same period of time, would involve a saving of $20 million. On the Byrd Station, which is the most attractive from the standpoint of economics, the estimate of saving is $37 million. These are Navy figures, by the way. They are not our figures. This is a total of something like $78 million that could be saved over a period of 20 years in the operation of nuclear plants there.

The testimony we have had before us indicated that you would have to replace the major part of your diesel plants up there every 2½ years. There is another point that is just as important, and that is the fact that in the last 3 years we have lost 17 lives, at least 80 percent of which could be ascribed to the duties of carrying freight in the form of fuel oil from the Zone of Interior to these remote installations. We have also lost some 18 aircraft, I believe, at a total cost of $10.5 million. The loss in aircraft alone would compensate for the additional capital investment at these remote installations.

So it is hard for this committee to see this type of worthwhile project, you might say, caught in the crevice between two budgets, the budget of the AEC and the budget of the Department of Defense.

We wondered if there could not be some joint arrangement between the using agencies and the AEC that would bring about the fruition of this project at a saving of dollars in the long run, as well as a long-run saving of the lives of our men in the service. Have you considered any kind of a joint program whereby this could be funded on the part of the AEC from the standpoint of the research and development of knockdown portable types of reactors, and on the part of your using agencies from the standpoint of the merit of the program, on the part of the taxpayers the saving of money, and on the part of the mothers and fathers of these boys, the saving of lives?

Mr. STAATS. Mr. Chairman, we would have no differences at all on the questions which you have raised with respect to the merits of these powerplants. We have not at this time, as I indicated in my statement, had any request from the Department of Defense to fund these plants.

Representative HOLIFIELD. Of course you haven't, because they don't have the priority position under the budgetary limitations and the priority position on the use of capital funds.

Mr. STAATS. That is not anything that has been fixed by the Bureau or by the Executive Office to the best of my knowledge.

Representative HOLIFIELD. Their ceiling on what they can ask for has been fixed by the Bureau.

Mr. STAATS. The ceiling on the budget was approved by the President as of last January. To the best of my knowledge, they did not request in that budget any funds for this program. To that extent, I don't believe there has been anything to date which has been slowed down or denied because of this problem that you have mentioned.

Representative HOLIFIELD. They are just told not to ask for it, in effect. They are just told that they have to cut their pattern to the amount of cloth that they have. Of course they can't ask for something. They have testified before this committee as to the economics that I have given you. There has been testimony from the Navy people. They testified before our committee as to the economics of it and the desirability of it. They are in the position where they can't ask for it because they are caught in this bind of priorities for other things and the limitation of the budget.

Mr. STAATS. All the agencies have this problem of budget limitations and priorities. That includes the AEC as well. As I pointed out, the DOD has financed, and the Bureau has concurred in, two of these plants already in the budget of the Defense Department. So it is not a matter of policy as to whether we do or do not approve this type of development.

Also, we have not raised any question on the financing arrangements with respect to the Navy and AEC for nuclear ship construction and development. So I think as a matter of principle we have already gone quite a long way in the direction of the full financing in the Department of Defense on similar developments. I wonder if there is not some misunderstanding as to whether there is a holdup here.

Senator ANDERSON. As a matter of fact, Mr. Staats, you know there is a holdup. The Navy would have to ask for a few million dollars more. They have to find that few million dollars by cutting down some other project. The Navy naturally would say we will go along with the other projects. We would not bother to save money because the scientific community is the one that is involved in the South Pole and not the Navy. The Navy is just the servicing agency. It does not help them any to cut a million or two from some other place to get a plant. Who has responsibility for trying to save this money? Here is a plant that pays for itself in 2½ years. That is a very advantageous thing.

Mr. STAATS. I would expect the Department of Defense in the first instance.

Senator ANDERSON. I just call your attention to the fact that we have just had a report on that on Guam, where the Navy wanted to do this very thing. It is contained in a letter from Mr. Douglas, Under Secretary of Defense, and he says that the Department of Defense proposed that the Atomic Energy Commission participate with the Navy for jointly financing a 20-megawatt electric nuclear power-

plant for Guam. He goes on and says, "Although this proposal was subsequently withdrawn because of the inability of the Navy to fund its share of the program in fiscal 1961, it was reaffirmed at the March hearings that the Navy intends to find the project for fiscal 1962." The basis for the joint funding of this project as outlined above is still valid. It is a good thing, but it is not done because they have a budget limitation and cannot spend the money.

Now you get down to the pole where 80 percent of your costs are for flying in fuel and nothing happens. Nobody can move. It costs four times as much for fuel to bring in the diesel fuel to turn over these plants as it does for the cost of the fuel itself. Everybody says this is economic waste, this is the silliest thing we have ever heard of, but nobody can get us off the dime. Whose responsibility is it to save this $20 million that the chairman mentioned to the Federal Government?

Mr. STAATS. Senator, I am aware of the figures in the study to which the chairman referred. I don't think that we would have any difference with you at all. The evidence which has been developed to date looks very convincing if you look at both total capital and operational costs on these plants in these remote military areas. I don't think we have, as a Bureau, any quarrel with that type of analysis on the basis of data we have seen to date. I think the point we are making is really a somewhat different point.

Senator ANDERSON. What is it?

Mr. STAATS. And that is this: The Department of Defense in the first instance has to make the assessment of priorities in its overall budget. As you noticed in the papers yesterday, the Secretary of Defense announced a pretty major reprograming within the 1961 budget. This avenue is always open. We have not as a matter of policy or as a matter of specific objection turned down any of these plants in the Defense budget at any time. We would expect this analysis and this judgment as to priorities to be made in the first instance in the Department of Defense. We think that is fundamental.

Senator ANDERSON. I am happy to hear you say you never turned this down because the Atomic Energy Commission came in with an item called nuclear powerplant, remote military installation, $11,600,000. Didn't the Bureau of the Budget turn that down?

Mr. STAATS. I am advised that was only partial financing of the plant by AEC.

Senator ANDERSON. Did the Bureau of the Budget turn it down, or didn't it?

Mr. STAATS. I am advised, Mr. Chairman, that the Navy did not have the funds budgeted for the conventional portion of that plant and the plant dropped out for that reason.

Senator ANDERSON. Did the Bureau of the Budget turn it down or didn't it?

Mr. STAATS. Not as a Defense budget item, sir.

Senator ANDERSON. In the Atomic Energy Commission budget did the Bureau of the Budget turn it down or didn't it?

Mr. STAATS. I think we did.

Senator ANDERSON. That is right.

Mr. STAATS. In the terms of the AEC part of it.

Senator ANDERSON. Precisely.

Mr. STAATS. The AEC request was not for the total cost of the plant. The Navy was not ready to go ahead with the rest of it.

Senator ANDERSON. I know that. Somebody though has some day got to get the feeling that we might save this money that could easily run to $80 million in the Antarctic. It is extremely expensive operating down there. That is not a Navy operation in the ordinary sense of the word. The Navy is merely the servicing agency, isn't it?

Mr. STAATS. The Navy has budget and operational responsibility in the Antarctic.

Senator ANDERSON. We don't seem to be able to agree at all on anything. I said to you the Navy is merely the servicing agency of the scientific community there.

Mr. STAATS. It is the logistic and service agency.

Senator ANDERSON. The Navy is not going to take money out of its other projects to help this project out when it is already limited, is it? So whose responsibility is it to get this thing underway and save this money?

Mr. STAATS. I think it would be the Navy's responsibility, Senator, if they felt they could use nuclear power economically.

Senator ANDERSON. The Bureau of the Budget has no responsibility toward the overall saving of money?

Mr. STAATS. We are the reviewing agency. We would not make the inital judgment that we think in this instance the Navy should make as between conventional power and nuclear power. I don't think you would feel it would be proper for us to direct the Navy to shift from one type of power to another.

Senator ANDERSON. I only think it is too bad that nobody can come to this decision. The Navy doesn't because it has to take money out of its pockets there on capital expenditures in order to help the scientific community. You don't give the scientific community money. When the AEC puts it in, you take it out of the AEC budget, because it ought to be done by the military. I many times illustrated this story. I had a young newspaperman working for me many years ago who was a tremendously heavy drinker, who met a lovely girl and wanted to marry her. She wouldn't marry him until he quit drinking, and he could not quit drinking until he married her. In the meantime the money is thrown away by the millions every year, and it is nobody's responsibility to try to stop it.

Here stands the Atomic Energy Commission, I think well equipped to build a reactor. I don't think you need elaborate design studies. I think there are men here who could automatically tell you how to build the plant. They have done it. I think they know exactly the type they could build. I would trust them blind. I would give them a few million dollars and say put one at McMurdo Sound, one at Byrd, and one at the Pole. You ought to have several around. When they did that, the Government in a 20-year period would save $80 million. If the budget is a problem, and it is, why not save the $80 million? Why let the fight go on? I am only trying to say to you, Mr. Staats, and we have had many discussions before, and you know I respect you thoroughly, why is it not somebody's job to say that these people must get together and decide to build these plants? The saving of lives is important. The saving of money is important. They should not be allowed to sit there and ignore it because it is nobody's job to get it done.

Mr. STAATS. Senator, I would be the last to suggest that this was not a proper question on the part of the committee. The committee obviously believes that this is an economical and desirable thing to do. Our position on it up to this point has been simply that we would wait for a request and evaluation in the first instance by the responsible agency, which in this case is the Navy and the Department of Defense. It may be, and I have not talked with the Department of Defense, that they have not yet reached the judgment in their own minds that this is an economical and desirable thing to do. Otherwise I would have assumed that Defense would have included it in their request.

Senator ANDERSON. Mr. Staats, if you will tell the military services that they have permission to exceed these budget levels, they have, by the amount necessary to build these plants in the Antarctic, I think they will give you a quick answer. Admiral Chew said to us in the hearing on March 11—

> Mr. Chairman, I think I should go back a little bit and explain that the reason it was not included in the 1961 budget—that is, money for the nuclear plant at Antarctica, the three stations—was purely the high initial cost. From the point of view of the Chief of Naval Operations, you cannot do all things to all people. This was unquestionably a national prestige item, but from the point of view of military requirements it suffered in comparison with the more urgent operational needs.

That is true, because from the military standpoint the Navy can't justify it because it is purely serving the scientific community. So when it comes to evaluating its military priorities it has to write off the plants in Antarctica. But the scientific community down there wants it badly. Then in the hearing they testified to that round after round after round. Who is the claimant for them?

Mr. STAATS. Mr. Chairman, I believe sincerely that you are under a misunderstanding as far as the Navy's role in the Antarctic is concerned. While it is quite true that they are a service and logistics agency, they also have been assigned by Presidential directive the operational responsibility in the Antarctic. It would be up to them to make this recommendation for a nuclear powerplant in the Antarctic.

Senator ANDERSON. I think I can find where the man representing the Navy used the very words I do. So if I am misinformed, I got it from him. I don't blame him because he was explaining that the work at the South Pole was not primarily the responsibility of the Navy. They were trying to serve the scientific community, and I think doing it very, very well. They fly the supplies in, fly personnel in, but the people who were there from Antarctica agreed that the Navy was a servicing organization. They are down there. They ought to know what is going on. Senator Jackson had flown twice over the pole and had been down in the area. He believes that to be true. I think it is true.

Mr. STAATS. I don't wish to engage in a debate on it with you. We have just completed an organizational study on the Antarctic, and while what you say is quite true, it does go beyond that. As far as budgeting and deciding what they need to fulfill their requirement in the Antarctic, that is clearly up to the Department of Defense and more particularly the Department of the Navy.

Senator ANDERSON. Yes, but what I am trying to say, the Department of Defense has its own priorities. So who is the claimant for

the scientific community? The scientific community has to submit it through the Navy. The Navy looks, and says do we want to spend several million dollars of our money down there or do we want to put it into the new type of submarine or something else? From a defense standpoint the Navy properly has to say the best way to spend our money for defense is for these other purposes, and not for a nuclear powerplant in the Antarctic. Therefore, round after round we continue to throw away millions of dollars a year because it is nobody's responsibility to try to save the money. Mr. Stans is a very competent businessman, and you, I happen to know, have extremely sound ideas. Why doesn't somebody come in and say we will raise the appropriation to somebody a little bit and let these plants be built? We have advocated that the budget of the Atomic Energy Commission be increased several million dollars, and they be allowed to build these plants. I believe they will build them as cheaply as can be built, probably more cheaply than any other organization, because I think they know more about that particular size and style of reactor. We would like to give them some money, and say God bless you, go ahead and never ask them a question about the design. The country will have a chance over 20 years to save $80 million. Wouldn't that be to the ultimate welfare of the country?

Mr. STAATS. Mr. Chairman, I would like to say this with respect to how you could arrange for the financing of these plants. There are two ways after a budget is once presented, as you well know, that you can provide for the additional funds. One is to go the route of a supplemental apropriation which would amend the budget. This is one of the ways it has been done in the past. The other way is to reprogram within the budget which has been presented to the Congress by reassessing priorities and adding the higher priority items within the overall totals. The reprograming which took place yesterday, as I think you are aware, has been announced in the framework of reprograming within the totals, so that an amendment to the budget to increase the totals is not required. I am not passing judgment at this point as to which of these two ways would be most appropriate in this instance. We would have to await a request from the Department of Defense before that consideration could be given.

Representative HOLIFIELD. In our letter dated March 15 to Mr. Stans, Director of the Budget, our concluding paragraph was:

> I hope you will cooperate with the Department of Defense and the Atomic Energy Commission in developing methods which will result in real economy in expenditures for these projects.

Was there any attempt to get together with the Department of Defense or the Atomic Energy Commission on this specific problem?

Mr. STAATS. Mr. Chairman, to the best of my knowledge, the Department of Defense has not raised this question with the Bureau. It is my understanding, based on the discussion we have had with them, that they contemplate building a large number of these plants over a period of time. As I told you, we have already included it in the Defense budget two such plants. We have similarly financed nuclear ships for the Navy very extensively, as you know. This has not presented any problems. So we are having a little difficulty on our side of the table in understanding really what the problem is, to be very honest with you about it.

Representative HOLIFIELD. Have you seen the letter of March 31 from the Department of Defense directed to the chairman?

Mr. STAATS. Yes, Mr. Chairman. I assume you refer to the letter of March 31 included in your press release. That letter was not discussed with us in advance of its transmittal.

Representative HOLIFIELD. They said they will make every attempt:

We will make every attempt to establish a funding system that will be satisfactory for the individual reactors or the program as a whole.

He said:

I agree that the construction of reactors at certain remote sites would be economically advantageous over the useful life of the plant, advance the art of reactor technology, enhance the prestige of the United States and be in the overall national interest.

This was signed by Mr. Douglas, Acting Secretary of Defense. Then he goes on and tells us what promising reactor projects have been reviewed. "The most promising reactor projects" and so forth. He gives us the information on Okinawa, Guam, Antarctica, Thule. It is a pretty good letter. They say they have other sites at which nuclear power might offer tangible advantage.

Mr. STAATS. Mr. Chairman, we would be very happy to pursue this discussion with Defense. We have certainly no reason, if the committee would like us to do so, not to pursue that discussion.

Representative HOLIFIELD. Do you think there could be any possibility at all of working out some kind of mutual funding where part of it would be charged to the ordinary costs of these far-off bases, and some of it possibly charged up to the thing which we are most interested in, which is the development of the art and technology of the portable reactors for sites such as this?

Mr. STAATS. I believe, if I am not mistaken, that the discussions have been in terms of using the proven type of reactors in these remote locations.

Representative HOLIFIELD. Yes. The studies have already been made. There are at least two, the so-called PM I and the PL. One of the studies was made by the Martin Co. and one by American Locomotive.

Senator JACKSON. And Combustion Engineering. There were three.

Representative HOLIFIELD. So the design work was done. We are ready to go. This is not something that has to be studied or put on the shelf or surveys made or anything like that. This is a military goal to develop this type of plant.

Mr. STAATS. I understand that.

Representative HOLIFIELD. They have spent money already on design studies. I am sure at this time they are building component parts and have their breakdown so that this plant can be divided up and put in these big heavy freight planes and carried up there piece by piece and assembled in a short time. One of our members, Senator Jackson, has been riding herd on this project. He has even visited these Antarctic bases. I would like to yield to him at this moment.

Senator JACKSON. Mr. Staats, I think we have before us today a classic example of a breakdown in the budgetary process. In your letter you make reference to the fact that this should be charged to Defense. This I agree. I don't think the Atomic Energy Commission should carry this item as a part of their budget because it does

add to their overall expenditures, and it is reflected later in the amount they spent. I made a trip in October to Antarctica. I visited McMurdo Sound. I flew over the pole twice, and flew over Byrd Station, the three areas that are involved in this particular item. If we continue to pursue the regular budgetary process, this project will never be included in any departmental budget. I say that because the Navy has the responsibility now. It is obvious that the Navy will give this a low priority, because it is not in support of one of their programs.

I presume if it is charged to any program, it might be the National Science Foundation. I do submit, however, that the tendency will continue to be, as it has been in the past, to treat this as an operational expense, because this will represent less money expended overall in any one fiscal year than if you treat this as capital expenditures. I do not criticize the Navy. I think they are caught in a bind here, as I said, Mr. Chairman, at one of the previous meetings. But just stop and consider the savings in money in this situation, and that is part of the job of the Bureau of the Budget. The preliminary estimate of the payout in connection with these projects, as I understand, is roughly as follows: McMurdo will pay out in 4.9 years. I understand you have covered this already. The Pole Station will pay out in 3 years and the Byrd Station in 1.3 years. All I can say is that I would hope that the Bureau of the Budget would take whatever steps are necessary to assist the Atomic Energy Commission in meeting this specific budgetary situation. Let the Commission go ahead with this program because it is obvious in the next 2 or 3 years you are going to save money. I don't believe it should in the end be tacked onto the overall expenditures of the Atomic Energy Commission. They should be given credit. They should be allowed some provision in the bill, Mr. Chairman, which would permit the transfer of the funds from the Department of Defense budget, or the National Science Foundation, with the money turned over to the Atomic Energy Commission for expenditure and management.

Mr. STAATS. Mr. Chairman and Senator Jackson, we agree that it is desirable to finance military nuclear powerplants in the Department of Defense. We think this is going to be a long-term program. We think there are going to be many of these plants. We have already financed two in the Department of Defense. We are financing the nuclear ships for the Navy through the Defense budget. We do not at this time have any reason to quarrel with the economics of the nuclear powerplant construction at these remote sites. We have not had a Defense budget request.

Senator JACKSON. Mr. Staats, if I may submit, factually this situation is not the same as the other projects, like small package reactors. The Navy is merely down there as an agent. They are providing the logistic support for the National Science Foundation under the direction of the Antarctic project office.

Mr. STAATS. I think I can clarify this point. The Antarctic support costs for the Navy always has been treated as a separate budgetary item. So the Navy in no sense has to absorb anything else if it adds to the Antarctic support that it provides for the scientific community. We have reviewed this as a completely separate budgetary item.

Senator ANDERSON. Are you sure of that, Mr. Staats?

Mr. STAATS. I think this is purely misunderstanding. As far as we are concerned, we have treated this as a separate item. I will tell you why. Otherwise you have no way of determining what your level of scientific support is going to be. This is the reason we came to that conclusion.

Senator JACKSON. Mr. Staats, I may be wrong, but the Navy has attempted to do something about this in the past, and the problem has been that they can't give it a high enough priority. They can't allow it to compete with other projects where they have operational responsibility. Their difficulty has been that the priority they must of necessity give it in relation to their day-to-day operational requirements is such that they could not approve this project with a priority high enough to be included in the budget for this year.

Mr. STAATS. As I indicated, we would be happy to work with Defense on this.

Senator ANDERSON. I can't quite hear you, and I want to hear you on this, because this is, I think, completely contrary to everything that the Navy has testified to. So you go right ahead about this separate pot that has no relationship to the other Navy budget and so forth.

Mr. STAATS. I can furnish you with documentation on this, Senator, in terms of the letters and other documents, so that there is no misunderstanding in our mind that this is the case. If the Navy Department on its own has made this judgment, then I am not aware of why they made this decision not to include this.

Senator ANDERSON. No, no. You just got through saying, as I understood you, and we will have to look at the record, that there was a separate appropriation that dealt with these Antarctica items and had no relation to the rest of the Navy budget. That is what I want you to elaborate on.

Mr. STAATS. That is correct.

Senator ANDERSON. So if the Navy wanted to, it could put in all these reactors, and it would have no bearing whatever on the Navy budget?

Mr. STAATS. We would treat this as a separate item for purposes of budget review, Senator, that is correct. We did this year.

Senator ANDERSON. I would like to have it yes or no. If the Navy puts these reactors in its budget and asks for them, that would have no bearing whatever on the Navy budget itself, that is, the regular Navy budget?

Mr. STAATS. That is correct, although the total amount for the Navy might still have to be adjusted within the totals.

Senator ANDERSON. You see! You didn't fool us. It has to come right back into the overall total, just as we said all the time.

Mr. STAATS. No.

Senator ANDERSON. Yes, exactly.

Mr. STAATS. As I explained while you were away——

Senator ANDERSON. We had it up one side and down the other. The Navy does admit this. But you run against an overall ceiling. That is what we have been saying. That is why I want you to be real sure of your language.

Mr. STAATS. Every time you have a new requirement you don't come to Congress and ask for a net additional amount of money for it.

This is the only point I am making. There have to be priorities and perhaps the Navy has to make that judgment in the first instance.

Senator ANDERSON. Yes; sure.

Senator JACKSON. That was the answer I was trying to get. The point we made earlier, Mr. Chairman, is correct. Let me ask you, Mr. Staats, this question: I am interested in a study I am making in the area of national security, and this is an example of what happens when you have such rigid budgetary policies. Here we are in a situation where the Government, if one of these projects could pay for what amounts to heavy operating costs in a little less than 2 years. Don't you give some priority on your own when you see an item like this? If you can avoid a lot of that heavy operating cost and have it paid out in a period, in this instance a little less than 2 years at one of the stations——

Representative HOLIFIELD. 1.3 years in the case of the Byrd Station.

Mr. STAATS. I assume this information is also available to the Navy. I don't know what the answer is.

Representative HOLIFIELD. The Navy gave it to us.

Senator JACKSON. They gave it to us, and they had it in their budget presentation. Obviously you put this overall ceiling on it. I don't blame the Navy. I defend the Navy in this situation.

Mr. STAATS. I am not a nuclear expert to judge this plant. I would say this. If it is absolutely correct, and there be no disagreement on everybody's part as to what you say, it sounds to me like it would be an awfully good business proposition to put it in on that basis.

Senator JACKSON. We are living in Washington, D.C., and it is a world of realities. The people running departments have to take care of their own problems first. Why should the Navy attempt to forego other critical operational projects in order to take care of capital expenditures that do not relate directly to their program? I think you have created a situation in the budget process where there is no real incentive to do this job. They are only going to do one thing, and that is to hold down their dollar expenditures for a given fiscal year.

Mr. STAATS. Haven't you made the judgment here that this is not a high priority item for the Navy?

Senator JACKSON. Yes, it is not a high priority item for the Navy. It is a high priority item for the taxpayer.

Representative HOLIFIELD. That is right.

Senator JACKSON. It is a high priority item for the Bureau of the Budget and the Treasury Department.

Mr. STAATS. The point I would like to emphasize, though, Senator Jackson, if this information has been judged by the Navy in the same way you have, then it seems to me it is up to them to make that request. They have never made such a request, and we have never rejected it on policy grounds.

Chairman ANDERSON. But you understand that the Navy does not want to do it. It has other obligations. I do not understand why the Bureau of the Budget does not get into the moneysaving question.

I remember a little item called Dixon-Yates in which the Bureau of the Budget took an active part and told the Atomic Energy Commission what to do. It was its responsibility to go way out of the field and go into that area. It had to do something.

That was all right for the Bureau of the Budget, but when it comes to saving some money, then it is nobody's responsibility.

Mr. STAATS. I want to make it very clear that as far as I am concerned, I was not in the Bureau at that time, and I cannot comment.

Chairman ANDERSON. Mr. Wenzel was brought down so he could tell the AEC what to do. Somebody thought Dixon-Yates was going to cost us $100 million. Here we have a chance to save $80 million. Why don't we try to save it?

I realize you can keep saying it is the Navy's responsibility to ask for it. But if a man is charged with the defense of the country and somebody offers him a choice between a gun and a free ride in an airplane, he is probably going to take the gun.

The Navy is down there trying to serve the scientific community and transport people in and out a little bit, but its main job is defense. Naturally, if the Navy is asked where it wants to spend its money, the Navy properly says, "We want to spend it for defense items and this construction of a nuclear powerplant is not a defense item."

The Navy is absolutely in the clear as far as I am concerned. I wish it could be compelled to do it.

Mr. STAATS. I am not saying that anybody is at fault here, Senator Anderson. As I indicated, we would be very happy to pursue this with the Department of Defense, if they have a desire to do so. We do not feel in this area, as we do in the organization and management field, that we are the experts on nuclear power development.

As far as the economies are concerned that result from this effort, we would have to rely on the judgment of the Atomic Energy Commission and the Navy Department, as well as the published materials to which you have referred.

Representative HOLIFIELD. Mr. Staats, we realize that the Bureau of the Budget is not expert in the atomic field. This committee does have some understanding of the problem. We have been wrestling with it for about 14 years.

I want to take you by the hand and gently lead you through the wilderness of some figures we have here. These figures were furnished us by the AEC in collaboration with the Navy, the best thinking both agencies could get, and they present this to us as being conservative and judicious estimates of what these different projects will cost.

I want your undivided attention, if your assistant will give me your left ear as well as your right ear. I will call to your attention that the conventional cost of the powerplants that are needed in these remote areas is estimated to be $20,034,000. The capital investment cost of the equivalent nuclear stations will amount to $37,585,000, or roughly $17½ million more.

That is the capital investment. This is where we run into our trouble. It is this capital investment that has caused us this trouble because it is the capital investment that goes above the limitation on the budget.

Now let us look at some of the background costs on this matter. The annual Department of Defense budget cost for the conventional plants amount to $7,802,000. This is what we are going to have to spend every year to keep these conventional plants going.

On the other hand, the annual Department of Defense budgeted cost of nuclear plants would be $2,629,000, or a saving of $5,173,000 a year. Over a period of 20 years, you can see what that would run. It would run in the neighborhood of between $85 and $100 million, according to the variation in size of the plants.

It is the Congress responsibility to look at the overall picture. It is the Navy's responsibility to look at their budget and it is the AEC's responsibility to look at their budget, and so on through every agency of Government.

But you, to a certain extent, occupy an overall look at the national budgetary situation even as we in the Congress have to. So our congressional responsibility goes to the producing of the taxes that pay these bills. It also goes toward saving wherever we can see a saving involved.

We see here a saving of possibly $85 million over a period of 20 years. Maybe it might run a little bit higher. We are not quite sure. We know you have to replace. It might run even double that if you count on the replacement of your conventional systems or the major parts of your conventional systems, such as your diesel engines, every 2 or 3 years. We understand they wear out and you have to take others in and replace them.

So we think we are using minimum figures here of $80 million. We are not putting in probably all the costs either way. I am not guaranteeing it to be accurate, but it is a pretty responsible estimate.

Under the figures I have given you, and I want you to study the figures after you leave the witness stand—we do not have you up here just to beat you over the head. We are serious about this. We see something here that is in the taxpayers' interest.

In my letter and in the chairman's letter, we asked the agencies to get together to try to solve this problem so these projects do not fall in the crevice between the budgets of the different agencies.

I am somewhat encouraged by your answer to the Senator when you said you would be willing to sit down again and look at this matter and look at it in terms of overall savings. We hope we can have some tangible evidence of this in the very near future.

Mr. STAATS. Thank you very much, Mr. Chairman. I think this helps clarify the setting for me a great deal. Our letter, as I emphasized, dealt only with the question of where the program should be financed. We have indicated that we felt that these plants should be funded by the Department of Defense.

Representative HOLIFIELD. I am not quarreling with you as far as your bookkeeping allocation is concerned. We are not quarreling with you on that. You have to have an allocation to certain agencies.

But where we see the mechanical result of this allocation when put together in total, when we see a waste, then I think it becomes certainly the Budget Bureau's as well as the Congress' responsibility to see if we cannot somehow eliminate it.

Mr. STAATS. If there can be agreement reached on these figures by the experts in AEC and Defense, we will be happy to work with them and to carry forward on that basis. I would like to emphasize that point.

I would like to emphasize one other point. As far as we are concerned, in our letter we were following a policy which we have fol-

lowed in the Bureau for many, many years, that the agency that is the primary user agency should be the one to include the item in its budget.

Then if that agency needs to call on the assistance of other agencies, there is legal authority and there are established procedures whereby they can transfer funds to the other agencies to get that assistance.

The Congress, in its report on the National Security Act of 1949, was very emphatic in its view that the financing of programs should be made the responsibility of the primary user agency. We feel that this is a sound principle. This goes back to 1949.

So our quarrel here today, I do not believe, is on anything other than the narrow point of procedure.

As I emphasized, we would be very happy to work with the AEC and Defense as far as looking at the economies of nuclear powerplant operation. We do not at any time look purely at capital costs. This would be foolish. We look at both capital and operating costs so that it is the long-term economy and not the short-term cost that governs.

Representative HOLIFIELD. I am very happy to hear you say that because this is what we are making our case on, the longrun economy.

Mr. STAATS. As far as how these projects would get authorized, this is really not a matter on which we feel we should make any judgment, irrespective of whether this comes from the Joint Committee or from the Armed Services Committee.

We feel that is a matter for the Congress to decide. We would feel, however, that, irrespective of the source of authorization, the primary responsibility for including funds for this purpose in the budget ought to be, in this case, in the Department of Defense.

Chairman ANDERSON. Mr. Staats, you went back to 1949. I am sure you would not mind me going back to 1921, then, and calling your attention to the United States Code, 1950 edition, title 31, section 16.

I am sure this is just exactly as it was, or I think it is just exactly as it was in the 1921 law.

There is hereby created in the Executive Office of the President the Bureau of the Budget.

I will not mention all the rest of it It says,

The Bureau, under such rules and regulations as the President may prescribe, shall prepare the budget and any proposed supplemental or deficiency appropriations, and to this end shall have authority to assemble, correlate, revise, reduce, or increase the requests for appropriations of the several departments or establishments.

Under that language, if you felt the Navy should have asked for money for these and did not, you could raise the Navy's budget and put in these plants, could you not?

Mr. STAATS. That is correct.

Chairman ANDERSON. We hoped you might do it. Under paragraph 18, the Bureau is to make these studies. I do not wish to read all the language, but the Bureau—

when directed by the President, shall make a detailed study of the departments and establishments for the purpose of enabling the President to determine what changes, with a view of securing greater economy and efficiency in the conduct of the public service, should be made, and so forth.

This is something that does represent economy. If the agencies are not able to do it, I see no reason why the Bureau of the Budget might not. In the letter Mr. Holifield and I sent to the Bureau, we said we hope you will cooperate with the Department of Defense and the Atomic Energy Commission in developing methods which will result in real economy in our Government expenditures for these projects.

That is the hope. Now, do I understand you to say that the items for these Antarctic operations are a separate budget item?

Mr. STAATS. This past year we reviewed the logistic support and other responsibilities of the Defense Department on the Antarctic as a separate item, Senator. This has been a troublesome problem for some time and I think there is no question about it that there has been some lack of clarity until the 1961 budget.

Chairman ANDERSON. We are still paying bills on the 1960 budget, are we not? Are they not actually under the 1960 budget spending their money now? Do they actually have any separate budget item as of today?

Mr. STAATS. We agreed with the Department of Defense as to the distinct amount that is available in the Department of Defense budget for the support of Antarctic programs; yes.

Chairman ANDERSON. For next year, maybe. What about this year? This is the one we are in. Have they got a separate budget item this year?

Mr. STAATS. That I would have to check. I know this is true for 1961. For 1960 I would have to check that.

Chairman ANDERSON. I asked that because I understood from them that they had to go out and beg and borrow and steal and try to find money all around the parade ground, and it did not seem to us they had a separate budget item.

Mr. STAATS. As of the present time, the directive is that the Science Foundation works with all of the agencies to pull together the requirements of the scientific community for the whole U.S. Government.

The Department of Defense is responsible for assuring that there is adequate funds and personnel and other logistic support to carry out our total program in the Antarctic, exclusive of the scientific side of it.

Chairman ANDERSON. Would that not look like they did not have a separate budget item? Doesn't someone know if the Bureau has a separate budget item? Does anybody here know?

Mr. STAATS. If you are talking about a separate appropriation as distinct for the Antarctic——

Chairman ANDERSON. Is there a difference between a budget item and an appropriation the way the budget is submitted?

Mr. STAATS. We would give them a separate amount in the total for the Antarctic program; that is right. This might be made up from one or more appropriations.

Chairman ANDERSON. Is Antarctica a separate budget item?

Representative HOLIFIELD. Will you identify yourself for the reporter?

STATEMENT OF CAPT. LEWIS C. COXE (CEC), USN, ASSISTANT CHIEF, PLANNING AND DESIGN DIVISION, BUREAU OF YARDS AND DOCKS, DEPARTMENT OF THE NAVY

Captain COXE. I am Captain Coxe of the Bureau of Yards and Docks. I am not a budgeter, Senator. All I do know is that in budgeting for the 1961 program for nuclear plants at the Antarctica, this item went in the Bureau of Yards and Docks civil engineering budget, which also supports all of our field and bureau activities.

If that at some later stage gets into a separate budget, I am not aware of it.

Chairman ANDERSON. What happened to it after it went into the budget?

Captain COXE. It got up through the process up to the Navy top management.

Chairman ANDERSON. And then it went out the window.

Captain COXE. It went out the window before it went out of the Navy.

Chairman ANDERSON. Precisely, because the Navy has other responsibilities. Far be it from me to criticize you for it. We know what happened to it, and so do you. It went out the window. As long as we have the present budgetary procedure, the Navy is going to try to help in the preparation of our defense and this is not as important to the defense of this country—I hope—as certain other items.

This is a moneysaving item. I am just hopeful. It is a lifesaving item, too, we feel. It is very important whether we have these crashes down there all the time with these boys who are flying down diesel fuel and using several gallons of gasoline to get down 1 gallon of diesel fuel. That does not seem to make sense.

Mr. STAATS. Mr. Chairman, it seems to me this suggests that the problem is in the Department of Defense rather than with us——

Chairman ANDERSON. I just read you what the budget law says about your responsibility to try to save money and to revise, reduce, or raise budgets if need be in order to accomplish that.

Mr. STAATS. This is a big Government. We have a very small staff, and we have to deal with big items.

Chairman ANDERSON. You cannot be expected to go out and find out if they are paying too much for drinking cups and rubber bands, but we have called this to your attention. Now what are you going to do about it?

Mr. STAATS. I have emphasized here several times that we would be happy to go into the matter further. I am not sure we have all the facts yet on this subject.

Chairman ANDERSON. You do not mind the Defense Department not saving the money, then?

Mr. STAATS. We have lots of problems with the Defense Department.

Senator JACKSON. Mr. Staats, first of all I want to say that I have known of your work personally and I respect you as an able public servant. I do not want you to take anything I say here or have said today as a personal reflection on your fine work.

I am distressed, as one Member of the Senate, with this cumbersome budgetary process. I am distressed about the whole budgetary procedure. I am not laying this at your doorstep. You have a difficult operation in which to try to do some good.

I do want to emphasize that here again is a classic case of a lack of pulling together and coordination in a very important field. It has been mentioned here that in addition to saving lives, you save money. Right at the time the budget was being made up, we signed a treaty with the Russians last October—that is about budget time—for the peaceful development of the Antarctic Continent.

It would occur to this individual that it might have been in order to give some consideration in connection with our foreign policy to really moving to implement that treaty and to do exactly what we agreed to do, namely, to provide for the peaceful development of the continent by building reactors in that area.

This would not be any phony psychological move. This would be a very realistic and very practical move. At the same time we would be the first in that area to bring the peaceful atom and to utilize it effectively.

Obviously you cannot get into all these items, but I hope that this colloquy here today and this presentation may not only save some money here, but will also cause the Bureau of the Budget to review some of their procedures.

When you mentioned that this should be included in the overall Defense budget, the same problem is involved as in your argument that it should be in the overall Navy budget, because there is an overall Defense budget ceiling.

I respectfully submit that the Secretary of Defense has to be concerned with first things first. First things first involves the support of our Military Establishment to meet day-to-day military requirements, operational needs, and then the long-term requirements.

One thing that is significant here is that if we can get the money—we will undoubtedly provide the money, but will it be funded? We understand that the Commission is in a position to call for proposals or bids by May 1, for possible decision by the 1st of July, with a unit ready for shipment dockside by November 1, 1961.

This means that it could become operational during the winter, which is summer down there, January–February of 1962, or somewhere in that neighborhood. I do believe with the know-how we already have that this is a realistic presentation that the Commission has made and it illustrates once again that if we can move now we can save money faster in this particular undertaking.

I would like to say further that while it should be charged to the Department of Defense, I think with the nature of this undertaking it may be wise from a management standpoint to have the Commission handle the proposals and administer the construction as an agent for the Department of Defense.

I believe this would be good management because we are not so far along that we would want to undertake this as a separate item for the Department of Defense. I do want to reiterate that nothing I have said here was intended as personal criticism of you. It is criticism of the institution of the budget, which I think we have to take a good hard look at.

Here is a graphic example of where the budgetary process and the techniques used do not achieve the objective that was intended.

Mr. STAATS. Thank you.

Senator JACKSON. This concludes my speech, Mr. Chairman.

Representative HOLIFIELD. Mr. Staats, as chairman of this subcommittee, of course, I cannot say what the subcommittee or the full committee will do. But as Senator Jackson and other members have indicated in their statements today and in their questioning, this committee is looking at this very carefully. I would not be surprised if they took steps to implement some of these savings that we see.

If we do take such steps, I trust you will bring to the attention of Mr. Stans some of the figures which have been given today, and also the results of the Kaiser study on this problem, and the result of the figures which we will furnish you from the AEC and the Navy on savings that are involved here.

If this subcommittee does take action from an authorization standpoint, we trust that our views and the Bureau of the Budget's views in the overall savings will coincide and that the blue pencil will be used sparingly.

Mr. STAATS. Thank you very much. I appreciate your courtesy.

Representative HOLIFIELD. You are excused, sir. Thank you very much for your testimony.

I want to add to what Senator Jackson said, that I have known you for a long time. You have been before committees that I have chaired before and we worked together back in the reorganization days on some matters, and I, too, admire the public service which you have rendered our Government.

Mr. STAATS. I appreciate that very much.

Representative HOLIFIELD. Mr. Shaw, do you have anything to add to this at this time? The Kaiser people are the ones who made this study.

STATEMENT OF DAVID F. SHAW, VICE PRESIDENT, KAISER ENGINEERS

Mr. SHAW. Mr. Chairman, it is a pleasure for me personally to be before this committee again after all these years.

Representative HOLIFIELD. We remember you very well from the AEC and the many times you appeared before.

Mr. SHAW. I would like to introduce my colleague, Mr. Don Daley, who was the project engineer who was in charge of the work we did on this. The work was under my general supervision.

The only general thing I might say is that I have reviewed the testimony which has been given here by the Commission with reference to our study and can say that it accurately presents the information which was contained in the work that we did.

I think the Kaiser engineer reports which have already been placed in your hands are self-explanatory as to how we went about making these estimates, what things are in them and what things are not in them. I am just available here for such questions as you may want to ask me, Mr. Holifield, about the studies.

Representative HOLIFIELD. Are there any questions of Mr. Shaw?

Senator JACKSON. No. I want to say like other colleagues on the committee, we have had the privilege of working with Mr. Shaw both as Assistant General Manager, and I knew him when he was Assistant Manager at Hanford, and Manager, and he rendered great public service during the long association with the atomic energy program, the Manhattan Project, and under the Commission.

Mr. SHAW. I am very honored to have you say that, Senator Jackson.

Representative HOLIFIELD. Mr. Shaw, before we adjourn, you have not yet finished the complete study on the Byrd and Pole Station.

Mr. SHAW. No, sir. We have not finished those two studies and we have not submitted them.

Representative HOLIFIELD. Can you finish those in an expeditious way so we could possibly have them before May 1?

Mr. SHAW. I think that the information which will be in them we certainly can make available through the Commission by that date.

Representative HOLIFIELD. Will they materially affect the estimates that have been given us?

Mr. SHAW. No.

Representative HOLIFIELD. Are you familiar with this sheet which was presented by the AEC to us in collaboration with the Navy?

Mr. SHAW. No. I have not seen the sheet but I read yesterday's testimony.

Representative HOLIFIELD. Will you take a copy of this sheet and study it tonight, and if there is any correction, additions, or deletions from the general summarization contained on it, will you present a memorandum to the staff on it before we go into session at 10 o'clock in the morning?

Mr. SHAW. I would be pleased to do that.

Representative HOLIFIELD. If it is possible to do that. I hope I am not asking you to do something impossible.

Mr. SHAW. The committee would realize that any comment made now would be based on what we know now. We are not finished with our work (see letter below).

Representative HOLIFIELD. This comes from your background study actually. I am not asking you to do something that you are not familiar with. I would like you to check and point out to the chairman of this subcommittee, if you can, if there is anything in it with which you have a divergence of opinion.

Mr. SHAW. We would be pleased to.

Representative HOLIFIELD. Thank you very much.

It is the intent of the chairman of the subcommittee to meet with his subcommittee tomorrow morning and afternoon and, in as expeditious a manner as possible, mark up the bill. It is very necessary because of the fact that some of our members are going to have to go to their districts for primary campaigns, and also because I have been notified that the chairman of the Appropriations Committee is waiting for this authorization bill, that we do this just as quickly as possible.

At this time the committee stands adjourned.

(Mr. Shaw's comments follow:)

HENRY J. KAISER CO.,
Washington, D.C., April 8, 1960.

Mr. JAMES T. RAMEY,
Executive Director, Joint Committee on Atomic Energy,
U.S. Capitol Building, Washington, D.C.

DEAR MR. RAMEY: At the hearing on April 7, 1960, the Subcommittee on Legislation requested that I review and comment on the tabulation of estimated costs of nuclear and conventional powerplants in Antarctica, which had been presented to the subcommittee on April 6, 1960, by Col. D. G. Williams, Assistant Director, Reactor Development Division, Atomic Energy Commission.

The estimate appearing in the first column under "McMurdo Sound" is based on the Kaiser engineers study. The second column under "McMurdo Sound" shows data for an alternate plant in which the number of reactors has been reduced from three to two, and the number of diesel generators (for the conventional plant) has been reduced from six to four. The cost estimates in this second column are consistent with those in the first column and are therefore reasonable—if 1,500 kw.-e firm power is adequate for the McMurdo Sound installation.

As you know, Kaiser Engineers has not completed its study of the Pole and Byrd stations. However, the data presented by Colonel Williams utilized, and is consistent with, information that we have developed to date. Based on this hasty review, I believe that our estimates, when completed, will not be significantly at variance with the estimates shown by Colonel Williams under the headings, "Pole Station" and "Byrd Station."

Very truly yours,

DAVID F. SHAW, *Vice President.*

(Whereupon, at 3:30 p.m., Thursday, April 7, 1960, the subcommittee adjourned.)

APPENDIXES

APPENDIX I

S. 3387 (H.R. 11713), 86TH CONGRESS, 2D SESSION, A BILL TO AUTHORIZE APPROPRIATIONS FOR THE ATOMIC ENERGY COMMISSION IN ACCORDANCE WITH SECTION 261 OF THE ATOMIC ENERGY ACT OF 1954, AS AMENDED, AND FOR OTHER PURPOSES

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SEC. 101. PLANT OR FACILITY ACQUISITION OR CONSTRUCTION.—There is hereby authorized to be appropriated to the Atomic Energy Commission in accordance with the provisions of section 261a.(1) of the Atomic Energy Act of 1954, as amended, the sum of $211,476,000 for acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion as follows:

(a) SPECIAL NUCLEAR MATERIALS.—

Project 61–a–1, modifications to production and supporting installations, $10,000,000.

Project 61–a–2, billet production plant, $1,800,000.

Project 61–a–3, heat treatment and inspection modifications, Fernald, Ohio, $2,500,000.

Project 61–a–4, development laboratory building, Oak Ridge, Tennessee, $766,000.

Project 61–a–5, plutonium reclamation plant, Hanford, Washington, $2,900,000.

Project 61–a–6, moderator purification improvements, Savannah River, South Carolina, $2,500,000.

(b) ATOMIC WEAPONS.—

Project 61–b–1, weapons production, development, and test installations. $10,000,000.

Project 61–b–2, high-velocity test track, Sandia Base, New Mexico, $2,100,000.

Project 61–b–3, special metals fabrication plant, $3,000,000.

(c) ATOMIC WEAPONS.—

Project 61–c–1, contaminated waste plant, Los Alamos, New Mexico, $2,000,000.

(d) REACTOR DEVELOPMENT.—

Project 61–d–1, additions and modifications to Chemical Engineering Building, Argonne National Laboratory, Illinois, $2,000,000.

Project 61–d–2, special purpose test installation addition, Santa Susana, California, $1,200,000.

Project 61–d–3, technical space for SPERT, National Reactor Testing Station, Idaho, $500,000.

Project 61–d–4, critical building, Brookhaven National Laboratory, New York, $600,000.

Project 61–d–5, fast reactor core test installation, Los Alamos Scientific Laboratory, New Mexico, $6,900,000.

Project 61–d–6, plutonium fuel service and development building, Los Alamos Scientific Laboratory, New Mexico, $600,000.

Project 61–d–7, test installation for Project Rover, $20,000,000.

Project 61–d–8, test installation for Project Pluto, $15,000,000.

Project 61–d–9, advanced test reactor, $24,000,000.

Project 61–d–10, power reactor plants for the Antarctic, $13,000,000.

(e) REACTOR DEVELOPMENT.—

Project 61–e–1, additions, and modifications, MTR–ETR area, National Reactor Testing Station, Idaho, $800,000.

Project 61–e–2, site utilities, Brookhaven National Laboratory, New York, $1,250,000.

Project 61–e–3, quarters for visiting scientists, Brookhaven National Laboratory, New York, $550,000.

(f) PHYSICAL RESEARCH.—

Project 61–f–1, bubble chamber house, Brookhaven National Laboratory, New York, $1,660,000.

Project 61–f–2, Princeton-Pennsylvania accelerator addition, Princeton, New Jersey, $10,820,000.

Project 61–f–3, accelerator and reactor additions and modifications, Brookhaven National Laboratory, New York, $1,085,000.

Project 61–f–4, high flux isotope reactor, Oak Ridge National Laboratory, Tennessee, $12,000,000.

Project 61–f–5, accelerator improvements, Lawrence Radiation Laboratory, California, $500,000.

Project 61–f–6, major bevatron improvements, Lawrence Radiation Laboratory, California, $9,600,000.

Project 61–f–7, design and engineering, linear electron accelerator, $3,000,000.

Project 61–f–8, materials research laboratory, University of Illinois, $5,600,000.

Project 61–f–9, radiation laboratory, University of Notre Dame, $2,200,000.

(g) PHYSICAL RESEARCH.—

Project 61–g–1, metallurgy building extension, Brookhaven National Laboratory, New York, $655,000.

Project 61–g–2, addition to cyclotron building, Lawrence Radiation Laboratory, California, $500,000.

(h) BIOLOGY AND MEDICINE.—

Project 61–h–1, installations for support of biomedical research in atomic energy, $5,000,000.

(i) COMMUNITY.—

Project 61–i–1, real estate development, Los Alamos, New Mexico, $435,000.

Project 61–i–2, elementary school addition, Los Alamos, New Mexico, $145,000.

Project 61–i–3, steam transmission line, Los Alamos, New Mexico, $135,000.

(j) GENERAL PLANT PROJECTS.—$34,175,000.

SEC. 102. LIMITATIONS.—(a) The Commission is authorized to start any project set forth in subsections 101 (a), (b), (d), (f), and (h), only if the currently estimated cost of that project does not exceed by more than 25 per centum the estimated cost set forth for that project.

(b) The Commission is auhorized to start any project set forth in subsections 101 (c), (e), (g), and (i), only if the currently estimated cost of that project does not exceed by more than 10 per centum the estimated cost set forth for that project.

(c) The Commission is authorized to start a project under subsection 101 (j) only if it is in accordance with the following:

1. For community operations, the maximum currently estimated cost of any project shall be $100,000 and the maximum currently estimated cost of any building included in such project shall be $10,000.

2. For all other programs, the maximum currently estimated cost of any project shall be $500,000 and the maximum currently estimated cost of any building included in such a project shall be $100,000.

3. The total cost of all projects undertaken under subsection 101(j) shall not exceed the estimated cost set forth in that subsection by more than 10 per centum.

SEC. 103. ADVANCE PLANNING AND DESIGN.—There are hereby authorized to be appropriated funds for advance planning, construction design, and architectural services, in connection with projects which are not otherwise authorized by law, and the Atomic Energy Commission is authorized to use funds currently or otherwise available to it for such purposes.

SEC. 104. RESTORATION OR REPLACEMENT.—There are hereby authorized to be appropriated funds necessary to restore or to replace plants or facilities destroyed or otherwise seriously damaged, and the Atomic Energy Commission is authorized to use funds currently or otherwise available to it for such purposes.

SEC. 105. CURRENTLY AVAILABLE FUNDS.—In addition to the sums authorized to be appropriated to the Atomic Energy Commission by section 101 of this Act, there are hereby authorized to be appropriated to the Atomic Energy Commission to accomplish the purposes of this Act such sums of money as may be currently available to the Atomic Energy Commission.

SEC. 106. SUBSTITUTIONS.—Funds authorized to be appropriated or otherwise made available by this Act may be used to start any other new project for which an estimate was not included in this Act if it be a substitute for a project or portion of a project authorized in subsections 101 (a), (b), and (c) and the estimated cost thereof is within the limit of cost of the project for which substitution is to be made, and the Commission certifies that—

(a) the project is essential to the common defense and security;

(b) the new project is required by changes in weapon characteristics or weapon logistic operations; and

(c) it is unable to enter into a contract with any person, including a licensee, on terms satisfactory to the Commission to furnish from a privately owned plant or facility the product or services to be provided in the new project.

SEC. 107. AMENDMENT OF PRIOR YEAR PROJECTS.—(a) Section 101 (d) of Public Law 84–506, as amended, is further amended by striking therefrom "Project 57–d–1, high energy accelerator, $27,000,000" and substituting therefor "Project 57–d–1, zero gradient synchrotron, Argonne National Loboratory, Illinois, $42,000,000."

(b) Public Law 86–50 is amended by striking out the figure "$5,000,000" for project 60–e–12, alterations to Shippingport reactor facilities, and substituting therefor the figure "$9,000,000".

SEC. 108. PROJECT RESCISSIONS.—(a) Public Law 86–50 is amended by rescinding therefrom authorization for a project, except for funds heretofore obligated, as follows:

Project 60–c–2, special processing plant, phase II, Mound Laboratory, Ohio, $3,800,000.

(b) Public Law 85–590, as amended, is further amended by rescinding therefrom authorization for projects, except for funds heretofore obligated, as follows:

Project 59–b–4, special processing plant, Mound Laboratory, Ohio, $2,000,000.

Project 59–c–8, lineal acceleration tester, Livermore, California, $390,000.

Project 59–g–3, gamma process development irradiator, $1,600,000.

(c) Public Law 85–162, as amended, is further amended by rescinding therefrom authorization for projects, except for funds heretofore obligated, as follows:

Project 58–b–5, additions to scrap plants, various sites, $1,500,000.

Project 58–c–2, weapons special component plant, $6,000,000.

(d) Public Law 84–506, as amended, is further amended by rescinding therefrom authorization for a project except for funds heretofore obligated, as follows:

Project 57–a–7, modifications to existing production facilities for increased efficiency and safety, Hanford, Washington, $3,000,000.

SEC. 109. COOPERATIVE POWER REACTOR DEMONSTRATION PROGRAM.—(a) Section 111 of Public Law 85–162, as amended, is further amended by striking out the date "June 30, 1960," in clause (3) of subsection (a) and inserting in lieu thereof the date "June 30, 1961."

(b) There is hereby authorized to be appropriated to the Atomic Energy Commission the sum of $40,000,000 to be available, in addition to the funds heretofore authorized, for carrying out the Commission's power reactor demonstration program in accordance with the terms and conditions provided in Sections 110 and 112 of Public Law 86–50. The maximum amount of the program authorization, specified in subsection 110(b) of Public Law 86–50, is increased by $45,000,000. In addition to the amount authorized under subsection 110(c) of Public Law 86–50, the Commission is authorized to use funds not to exceed $15,000,000 in the aggregate, to provide research and development assistance in support of unsolicited proposals from the utility industry to construct nuclear powerplants.

(c) Section 110 of Public Law 86–50 is amended by deleting the word "two" in the first sentence of subsection (d).

SEC. 110. COOPERATIVE RESEARCH AND DEVELOPMENT PROGRAM WITH CANADA.—There is hereby authorized to be appropriated to the Commission, in accordance with the provisions of section 261(a)(2) of the Atomic Energy Act of 1954, as amended, the sum of $5,000,000 for use in a cooperative program of research and development in connetcion with heavy water moderated nuclear powerplants to be conducted under the Agreement for Cooperation Concerning Civil Uses of Atomic Energy Between the Government of the United States of America and the Government of Canada, signed on the 15th day of June 1955, as now or hereafter modified.

SEC. 111. DESIGN AND ENGINEERING STUDIES.—The Commission is authorized within its discretion to proceed with design and engineering studies to include, but not be limited to, the following:

(a) Facilities for food irradiation;

(b) Power reactor of steam-cooled type.

The Commission may submit reports on studies under this section to the Joint Committee on Atomic Energy by April 1, 1961.

APPENDIX II

CIVILIAN POWER REACTOR PROGRAM—PLANS FOR DEVELOPMENT

Presented to the Joint Committee by the Atomic Energy Commission on February 16, 1960

INTRODUCTION

1. The first phase of a continuing study to develop long-range plans for the civilian power reactor program has been completed. Most of the information developed to date as part of this study is included in four reports. These reports, listed below, will be published and given public distribution.

(*a*) "Civilian Power Reactor Program, Part I, Summary Current Status of Reactor Concepts." [1]

(*b*) "Civilian Power Reactor Program, Part II, Economic Potential and Development Program."

(*c*) "Civilian Power Reactor Program, Part III, Technical Status."

(*d*) "Civilian Power Reactor Program, Part IV, Plans for Development."

These reports represent the first phase of a continuing study to develop long-range plans for the civilian power reactor program. Additional reports on the results of the continuing study will be published as appropriate.

2. In developing the program plans presented in the current report, primary attention has been given to the technological development required to achieve economically competitive nuclear power. Consequently, the development of prototypes for large central station powerplants figures prominently in the program. This should not be construed as indicating a diminution of Commission interest in, or support of a small power reactor program directed to achieving economically competitive nuclear power in plant sizes below 50 electrical megawatts. A number of the reactors presently being built or planned will contribute to attaining this objective. As more information becomes available and is evaluated concerning these and other reactors, including military programs, additional prototypes of small power reactors will be considered for construction.

3. Our current program follows the orderly three-phase sequence for the development of individual reactor concepts as described to this committee in our testimony last year. This sequence, in general, contemplates construction first of reactor experiments or experimental reactors, followed by prototypes and then by plants of commercial proportions. It is the opinion of the Commission that the reactor experiments should be built and operated by the Commission. Prototypes should be built and operated by publicly or privately owned utilities independently or in cooperation with the Commission. Alternatively, prototypes could be built and operated by the Commission. Industry should assume the primary responsibility for large commercial size nuclear power stations; however, the Commission will consider possible assistance on initial plants in various concepts useful for demonstration purposes. We believe it important that the large plants and, as far as possible the prototypes as well, be integrated into utility power grids in order to demonstrate load factors, dependability, and other operating characteristics which affect the economics of the plants.

4. Experimental and prototype reactors will be constructed as a part of the Commission's program when the plans for experimental work indicate that the technical or economic information and operating experience to be derived from the facility is essential to the Commission, or to the power industry, in the efforts to reduce the cost of nuclear power. In the development, construction, and operation of prototype and full-size power producing reactors, the Commission will work cooperatively with reactor manufacturers and with publicly and privately owned utilities.

5. Any arrangements whereby the Commission provides significant financial support will include provisions to assure that an experimental testing program can be carried out with the reactor during its early operation. Testing programs will vary with each project. When power generation is involved, this fact will be taken into account when establishing the testing program.

6. We plan a continuing evaluation and reappraisal of our program. New ideas and new technologies, including those developed in other countries will be reflected in this continuing evaluation. Periodic program reviews will consider carefully the relative merits of various lines of development looking toward reduction or elimination of some efforts, and initiation of, or increases in others. Should information indicate that a concept is not useful in meeting our objectives, the concept would be dropped.

PROGRAM OBJECTIVES

7. In previous reports and testimony before the Joint Committee on Atomic Energy (February 1959 hearings on the "Development, Growth, and State of the Atomic Energy Industry"), the Commission set forth the following five objectives for its civilian power program:

First: Reduce the cost of nuclear power to levels competitive with power from fossil fuels in high-energy cost areas of this country within 10 years.

Second: Assist friendly nations now having high-energy costs to achieve competitive levels in about 5 years. This assistance is to be extended mainly through clearly defined programs of cooperation.

Third: Support a continuing long-range program to further reduce the cost of nuclear power in order to increase the economic benefits and extend these benefits to wider areas.

Fourth: Maintain the U.S. position of leadership in the technology of nuclear power for civilian use.

Fifth: Develop breeder-type reactors to make full use of the nuclear energy latent in both uranium and thorium, recognizing that U^{235} alone may not be sufficiently plentiful to meet our needs over the long range.

8. The first and third objectives are directly applicable to the development of central station powerplants, and they have been used as the principal factors in establishing that part of the program outlined herein which deals with these plants.

9. In order to permit a more exact statement of the initial goal of the program, the first objective has been further defined as follows:

(*a*) The 10-year period is measured from 1958, when the objective was first stated. This establishes 1968 as the target date for achieving competitive power in high-cost energy areas.

(*b*) It is considered that competitive nuclear power will have been achieved when utility executives can decide to build nuclear stations based on economic considerations.

(*c*) High-cost energy areas are considered to be those areas where fossil fuels presently cost 35 cents per million B.t.u. or higher.[2]

10. No attempt has been made to assign a quantitative definition to the third objective either with regard to time or to the extent of the "wider areas." This objective is the basis for the longer range development program aimed at lowering the cost of nuclear power to a point where it is competitive with fossil power in ever-increasing areas of this country.

11. The other three objectives are more general in nature. With the passage of time and events, conditions relating to two of the objectives have changed substantially.

(*a*) The second objective relates to the achievement of economic nuclear power abroad. When this objective was first stated, it appeared that it could be achieved first in Western Europe in about 5 years. In the last 2 years the increased availability of fossil fuels and the drop in their shipping

[2] Conventional power costs in these areas are estimated to be about 7 mills per kilowatt-hour for a 300-MWE single unit fossil fuel station using fuel costing 35 cents per million B.t.u. (200 p.s.i.a., 1,050° initial/1,000° F. reheat, 1½ inches of mercury back pressure) based on 1959 cost levels, no escalation, 80 percent capacity factor and 14 percent fixed charges.

costs have brought the timetable of achieving economic nuclear power in Europe closer to that of the United States.

(*b*) The fifth objective recognizes the long-term importance of the development of nuclear power systems which can use a major fraction of the uranium and thorium available. At the present time it is not possible to make an accurate prediction of the time when uranium shortages and rising costs associated with such shortages will make the more efficient use of source material a vital factor. However, the ultimate importance of conservation of nuclear fuel dictates a long-range program to develop the breeding potential inherent in both the uranium 238-plutonium and the thorium uranium 233 fuel cycle.

There has been no change in the fourth objective. The Commission has endeavored and will continue to strive to maintain the United States in a position of leadership in atomic energy use for civilian purposes.

Specific Programs

12. Necessary congressional authorization will, of course, be sought before proceeding with new projects considered in the following concept-by-concept review.

I. LIGHT WATER-COOLED REACTORS

13. There is a relatively high probability that light water-cooled reactors in the reasonably near future can achieve competitive power in the high fuel cost areas of the United States where large single units are practical. In addition, water reactors also offer a longer range potential for being competitive in many other areas of the United States.

14. Over the next 4 or 5 years, Commission-supported research and development work on water reactors will be aimed primarily at solutions of the problems of nuclear superheat, increased fuel life, decreased fuel costs, simplified fabrication techniques, fuel management, simplified and less costly containment methods, and cheaper materials and methods of construction.

15. A major effort will be made to develop techniques for economically utilizing plutonium as a fuel material in water reactors.

16. The water-cooled reactor program is described under three categories: Pressurized water, boiling water, and nuclear superheat.

A. Pressurized water reactors

17. The pressurized water reactor concept is technologically well advanced and is the concept with which we have had the most experience. This experience has demonstrated that pressurized water reactors are safe, dependable, and reasonably easy to control. Capital costs of a 300-MWE plant of this type, as quoted recently by the manufacturers on a fixed-price basis, when taken in conjunction with fuel guarantees reported to the Commission by utilities and core manufacturers, indicate that the power produced from such a plant constructed now should be competitive over its life in high fuel cost areas of the United States where a plant of this size can be used.

Plans for Use of Existing or Authorized Facilities

18. *Domestic civilian power program.*—(*a*) The reactor at the Shippingport, Pa., Atomic Power Station will be modified to raise its power to 150 MWE equivalent. It will continue to be operated to demonstrate the life potential of the present rod-type blanket elements as well as of the newly developed high power density flat oxide feed and blanket elements. The present core will then be replaced by the newly developed 150 MWE high power density flat plate oxide seed and blanket core. The reactor plant and its associated facilities will be used also to further demonstrate the technical and economic feasibility of the seed and blanket concept. The developmental cores to be installed at Shippingport upon completion of the PWR core-2 lifetime will depend on the results obtained in the development, testing, and operation of PWR core-2. For example consideration will be given to the installation of still higher power cores if feasible and/or the utilization of other fuel materials such as plutonium, uranium 233, and thorium in this developmental reactor facility.

(*b*) The Yankee Atomic Electric Co. plant at Rowe, Mass., is scheduled for criticality in 1960. It will operate initially at 110 MWE. Among the important new features to be tested in the plant are stainless steel-clad slightly enriched

uranium dioxide fuel elements and solution poison for shutdown control. Statistically important utility operating and maintenance experience will be gained from this relatively large-scale reactor operating principally as a power producer.

(*c*) Two pressurized water reactors are being built by private industry without substantial Government assistance: A 151-MWE reactor is being built by the Consolidated Edison Co. of New York at its Indian Point, N.Y. plant which, with conventional superheat, will produce 255 MWE. It is scheduled to go critical in 1961. A 5-MWE reactor experiment is to be added to the Pennsylvania Electric Co.'s Saxton plant at Liberty, Pa., and is scheduled to go critical in 1962. These plants will add much information to the technology of pressurized waterplants. The Indian Point plant will provide important operating data for large water-cooled reactor systems and technical data on the use of thorium U^{235} fuel mixtures.

(*d*) A 40-thermal megawatt process heat reactor is to be built in California in cooperation with the Department of Interior. It is scheduled to go critical in 1962. This reactor will explore the economics of reactors for production of low-temperature, low-pressure steam for use by the process industries.

(*e*) A 16-MWE prototype with 6 MWE conventional superheat will be built primarily to demonstrate the economics of pressurized water reactors as small-power reactors. This reactor will provide operating information important to the design of large pressurized water reactors. The feasibility of bulk boiling in pressurized water reactors will also be demonstrated in this reactor. Five proposals have been received for this reactor to be built under a second-round type authority. The target date for criticality is 1962.

19. *Military and maritime contributions.*—(*a*) The Navy will put into operation a large number of nuclear-powered submarines and surface ships in the next few years. The supporting research and development work for these reactors has contributed and will continue to contribute significant data to the civilian reactor program. The natural circulation prototype reactor to be built at the National Reactor Testing Station (NRTS) may be of particular interest to the small-power reactor program.

(*b*) The Army reactor program will develop much information of value to the civilian reactor program. Civilian reactor development will benefit from the standardization of components and materials which will be a natural outgrowth of the Army program. The studies on use of reactors in remote military locations will be of particular importance in developing safe, reliable small nuclear powerplants for use under a variety of climatic conditions in all parts of the world.

(*c*) The pressurized water reactor installed abroad the NS *Savannah* should contribute important technology to the civilian reactor program, and in particular to the future of maritime nuclear propulsion.

20. In addition to the work being done in this country, design, construction, and operating experience will also be obtained from SELNI in Italy and the Mol plant in Belgium.

Future plans

21. It is probable that at least one additional pressurized water prototype will be justified by research and development results and operating experience. Such a prototype would be designed to demonstrate improved technology growing out of the operation of the Shippingport, Yankee, and Indian Point plants, and out of development and design of the other reactors listed previously. This prototype, if justified by developments and analysis, would incorporate improvements in plant design, construction, containment, and components which would lead to lower power costs. Design of such a plant could be begun in 1962 with construction starting in 1963 or 1964.

22. If the development work which is being initiated this year on the spectral shift[3] variation of pressurized water systems is successful, and the idea still appears promising, construction of another prototype reactor, possibly 50–100 MWE, to demonstrate this technology and its economics also would be started in the early 1960's.

23. As has been discussed before, information submitted to the Commission by reactor manufacturers indicates that utility managements may be in a position

[3] The spectral shift reactor is one in which heavy water is added to the light water coolant. Initially a high concentration (75 to 80 percent) of heavy water is used. As the fuel burns the concentration of heavy water is reduced (to about 25 percent) in order to harden the average neutron spectrum and extend fuel life.

costs have brought the timetable of achieving economic nuclear power in Europe closer to that of the United States.

(*b*) The fifth objective recognizes the long-term importance of the development of nuclear power systems which can use a major fraction of the uranium and thorium available. At the present time it is not possible to make an accurate prediction of the time when uranium shortages and rising costs associated with such shortages will make the more efficient use of source material a vital factor. However, the ultimate importance of conservation of nuclear fuel dictates a long-range program to develop the breeding potential inherent in both the uranium 238-plutonium and the thorium uranium 233 fuel cycle.

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16. The water-cooled reactor program is described under three categories: Pressurized water, boiling water, and nuclear superheat.

A. Pressurized water reactors

17. The pressurized water reactor concept is technologically well advanced and is the concept with which we have had the most experience. This experience has demonstrated that pressurized water reactors are safe, dependable, and reasonably easy to control. Capital costs of a 300-MWE plant of this type, as quoted recently by the manufacturers on a fixed-price basis, when taken in conjunction with fuel guarantees reported to the Commission by utilities and core manufacturers, indicate that the power produced from such a plant constructed now should be competitive over its life in high fuel cost areas of the United States where a plant of this size can be used.

Plans for Use of Existing or Authorized Facilities

18. *Domestic civilian power program.*—(*a*) The reactor at the Shippingport, Pa., Atomic Power Station will be modified to raise its power to 150 MWE equivalent. It will continue to be operated to demonstrate the life potential of the present rod-type blanket elements as well as of the newly developed high power density flat oxide feed and blanket elements. The present core will then be replaced by the newly developed 150 MWE high power density flat plate oxide seed and blanket core. The reactor plant and its associated facilities will be used also to further demonstrate the technical and economic feasibility of the seed and blanket concept. The developmental cores to be installed at Shippingport upon completion of the PWR core-2 lifetime will depend on the results obtained in the development, testing, and operation of PWR core-2. For example consideration will be given to the installation of still higher power cores if feasible and/or the utilization of other fuel materials such as plutonium, uranium 233, and thorium in this developmental reactor facility.

(*b*) The Yankee Atomic Electric Co. plant at Rowe, Mass., is scheduled for criticality in 1960. It will operate initially at 110 MWE. Among the important new features to be tested in the plant are stainless steel-clad slightly enriched

uranium dioxide fuel elements and solution poison for shutdown control. Statistically important utility operating and maintenance experience will be gained from this relatively large-scale reactor operating principally as a power producer.

(*c*) Two pressurized water reactors are being built by private industry without substantial Government assistance: A 151-MWE reactor is being built by the Consolidated Edison Co. of New York at its Indian Point, N.Y. plant which, with conventional superheat, will produce 255 MWE. It is scheduled to go critical in 1961. A 5-MWE reactor experiment is to be added to the Pennsylvania Electric Co.'s Saxton plant at Liberty, Pa., and is scheduled to go critical in 1962. These plants will add much information to the technology of pressurized waterplants. The Indian Point plant will provide important operating data for large water-cooled reactor systems and technical data on the use of thorium U^{235} fuel mixtures.

(*d*) A 40-thermal megawatt process heat reactor is to be built in California in cooperation with the Department of Interior. It is scheduled to go critical in 1962. This reactor will explore the economics of reactors for production of low-temperature, low-pressure steam for use by the process industries.

(*e*) A 16-MWE prototype with 6 MWE conventional superheat will be built primarily to demonstrate the economics of pressurized water reactors as small-power reactors. This reactor will provide operating information important to the design of large pressurized water reactors. The feasibility of bulk boiling in pressurized water reactors will also be demonstrated in this reactor. Five proposals have been received for this reactor to be built under a second-round type authority. The target date for criticality is 1962.

19. *Military and maritime contributions.*—(*a*) The Navy will put into operation a large number of nuclear-powered submarines and surface ships in the next few years. The supporting research and development work for these reactors has contributed and will continue to contribute significant data to the civilian reactor program. The natural circulation prototype reactor to be built at the National Reactor Testing Station (NRTS) may be of particular interest to the small-power reactor program.

(*b*) The Army reactor program will develop much information of value to the civilian reactor program. Civilian reactor development will benefit from the standardization of components and materials which will be a natural outgrowth of the Army program. The studies on use of reactors in remote military locations will be of particular importance in developing safe, reliable small nuclear powerplants for use under a variety of climatic conditions in all parts of the world.

(*c*) The pressurized water reactor installed abroad the NS *Savannah* should contribute important technology to the civilian reactor program, and in particular to the future of maritime nuclear propulsion.

20. In addition to the work being done in this country, design, construction, and operating experience will also be obtained from SELNI in Italy and the Mol plant in Belgium.

Future plans

21. It is probable that at least one additional pressurized water prototype will be justified by research and development results and operating experience. Such a prototype would be designed to demonstrate improved technology growing out of the operation of the Shippingport, Yankee, and Indian Point plants, and out of development and design of the other reactors listed previously. This prototype, if justified by developments and analysis, would incorporate improvements in plant design, construction, containment, and components which would lead to lower power costs. Design of such a plant could be begun in 1962 with construction starting in 1963 or 1964.

22. If the development work which is being initiated this year on the spectral shift[3] variation of pressurized water systems is successful, and the idea still appears promising, construction of another prototype reactor, possibly 50–100 MWE, to demonstrate this technology and its economics also would be started in the early 1960's.

23. As has been discussed before, information submitted to the Commission by reactor manufacturers indicates that utility managements may be in a position

[3] The spectral shift reactor is one in which heavy water is added to the light water coolant. Initially a high concentration (75 to 80 percent) of heavy water is used. As the fuel burns the concentration of heavy water is reduced (to about 25 percent) in order to harden the average neutron spectrum and extend fuel life.

to make decisions now to build large pressurized water plants in high-fuel-cost areas in which large plants are practical, basing their decision on economic considerations. The construction and operation of one or more such plants as a part of utility systems located in such areas would play a valuable role in the development of economic large central station nuclear powerplants.

24. The studies which are currently being made with respect to the feasibility of reactor-generated power in remote locations together with the technical information developed in Army and Navy reactor programs may indicate the desirability of initiating in 1962 a small power reactor prototype (20 to 30 MWE) at some installation which would offer a test of reliability under varying conditions.

B. Boiling water reactor program

25. The technical feasibility of boiling water reactors has been successfully demonstrated by the BORAX experiments at the National Reactor Testing Station in Idaho, the experimental boiling water reactor at Argonne National Laboratory and the Vallecitos boiling water reactor in California. Based on currently available information there is every reason to believe that the large Dresden plant now in initial operation, the Humboldt Bay plant, and the Rural Cooperative Power Association Elk River plant, all using boiling water reactors of varying size and design, will operate successfully and will furnish valuable information.

Plans for Existing and Authorized Facilities

26. *Domestic civilian power program.*—(*a*) The modifications now underway on the experimental boiling water reactor which will raise its power to 100 MWT, will be completed and the experimental program of study of the behavior of the boiling water system will be resumed. The modified reactor will be used initially to demonstrate the stability of a boiling reactor at higher power density, and it will serve as a boiling water fuel element test facility. Plutonium fuel development and water chemistry will be studied in this reactor.

(*b*) The 16 MWE indirect cycle boiling water with 6 MWE conventional superheat, Elk River plant, is scheduled for criticality in 1960. This reactor is primarily of interest in the small powerplant program. Experience gained from it will also aid in the evaluation of certain variations in boiling water reactor design of possible interest to larger plants. These variations include use of mixed thorium oxide and uranium oxide fuels and of an intermediate heat exchanger in a boiling system.

(*c*) Three boiling water reactors have been built, or are being built, by private industry without substantial Government assistance. General Electric's 20 MWT (5 MWE) Vallecitos boiling water reactor near Pleasanton, Calif., is being modified. Commonwealth Edison Co.'s 180 MWE Dresden nuclear power station at Morris, Ill., has gone critical, and the 48 MWE Humboldt Bay (Calif.) reactor of the Pacific Gas & Electric Co. is scheduled to go critical in 1962. The experimental and operational data from these reactors will add much information on the technology of boiling water reactors and the latter two will provide valuable statistical operation and maintenance data for water-cooled reactor systems. The programs of these reactors will supplement the work being carried out in plants built with Government support, and will be an important part of this country's overall program for the development of boiling water reactors.

(*d*) Construction of a 50–75 MWE high power density boiling water prototype is planned to begin in 1960 with criticality scheduled for 1963. This plant will be designed and operated in such a way as to provide technical and economic information on operation at power densities of the order of 60 kilowatts per liter and at fuel lifetimes similar to those experienced at lower densities. Negotiations are currently underway between the Commission, the Consumers Power Co. of Michigan, and the General Electric Co. to develop a mutually satisfactory cooperative program for this reactor. Information from this program will be of value to both large and small power stations.

(*e*) A simplified 50 MWE boiling water prototype reactor will be constructed to demonstrate design improvements which will reduce the size, complexity, and cost of boiling water reactors. Such features as improved control methods, simplified containment, elimination of high risers, and increased power output per unit of waterflow will be incorporated in the design. Invitations have been issued for proposals from interested utilities. It is expected that con-

struction will start in 1960 or early 1961. The target date for criticality is 1964. While this reactor will be primarily a prototype for future large reactors, the engineering improvements made will, in general, be equally applicable to small reactors.

27. In addition, Italy will build the 150 MWE SENN reactor. It will contribute experience in design, manufacturing, operating, and maintenance for a large boiling water reactor plant. Information developed will be available to the Commission and to industry through an exchange program.

Future plans

28. Aside from developments involving nuclear superheat which are described elsewhere in this report, most of the currently foreseen developments in boiling water technology probably will be demonstrated with reactors currently in operation, being built, or authorized. When operating experience is available from these reactors, in 1963 or 1964, it will be possible to determine what, if any, additional experimental or prototype reactors are needed to achieve competitive power in large reactors. Until such a determination is made, no further construction of large boiling water experimental or prototype reactors is contemplated by the Commission.

29. In the small reactor field, results from Elk River, Humboldt Bay, and the simplified reactor project discussed earlier may indicate in 1963 or 1964 the need to initiate construction of a small (20–30 MWE) prototype.

30. As in the case of pressurized water reactors, we have been advised by a manufacturer that a 300-MWE boiling water plant can be built now on a fixed-price basis, with certain fuel cost guarantees, which may produce power competitive with conventional power in certain high cost fuel areas of the United States. It is the Commission's opinion that the construction of one or more boiling water plants by utility companies in high cost areas where plants of this size may be practical would make a significant contribution to the development of economic power.

C. Nuclear superheat

31. Nuclear superheat can be applied to both direct- and indirect-cycle boiling water reactors, and to indirect-cycle pressurized water reactors. In direct-cycle boiling water reactors, nuclear superheat may be integral. In indirect-cycle reactors, whether boiling or pressurized, what is essentially a separate steam-cooled reactor would be required to obtain nuclear superheat.

32. Nuclear superheat would make possible production of steam at temperatures and pressures used in modern conventional powerplants of high efficiency. Development work and design studies have been underway for some time, concentrating chiefly on the superheat fuel element. Data from these programs are applicable to both direct-and indirect-cycle reactors. Design studies and evaluations have been made on integral superheat systems, and soon will be initiated on separate superheat systems.

Plans for Existing and Authorized Facilities

33. *Domestic civilian power program.*—(*a*) The fifth boiling reactor experiment (BORAX 5) is under construction at the National Reactor Testing Station and is scheduled to become critical in March of 1961. The reaction will be operated initially with a limited number of test channels producing superheated steam and will be converted gradually into an integral nuclear superheat reactor. Flexibility designed into the system will permit investigations of nuclear stability problems associated with various fuel and coolant arrangements.

(*b*) The Northern States power (62 MWE) plant near Sioux Falls, S. Dak., is under construction and is scheduled for criticality in 1962. This reactor will provide test and operating data on a high density, integral nuclear superheat core. Development work leading to reduction in the enrichment of fuel in the superheat section of the core will continue.

(*c*) A contract has been signed with the Puerto Rico Water Resources Authority for construction of a 16-MWE boiling nuclear superheat reactor (BONUS). This reactor will provide information on the practicality of an integral nuclear superheat design for small reactors, and will assist in the evaluation of nuclear superheat in large plants. The target date for criticality is early 1963.

Future Plans

34. If the technical and economic information obtained from these projects confirms the prediction that nuclear superheat can substantially lower power costs in boiling water reactors, a 100-MWE prototype would probably be required to exploit the full potential of the system. Such a prototype, if justified, probably would be initiated in 1963.

35. If the program outlined above is followed and it proves successful, it is anticipated that by 1968–69 sufficient technical and economic information will be available to permit utilities in certain areas of the country to decide on economic grounds, to construct a large (300 MWE) integral superheat plant.

II. ORGANIC-COOLED REACTOR PROGRAM

36. There is relatively high probability that organic-cooled reactors can achieve competitive power in high-fuel-cost areas of the United States by the middle 1960's and in the longer range over many other areas. Because of the success in operation of the organic-moderated reactor experiment and in other research and development work already done, because of the relative simplicity of the system, and because of the direct applicability of much of the technology developed in water reactor programs, it is believed that this concept can achieve its early potential with less research and development and construction of experimental and prototype plants than are required for other reactor concepts.

37. Organic-cooled reactors operate at higher temperatures and lower pressures than water reactors, and have no major corrosion problems. These characteristics make for low capital cost plants. However, high costs for replacing decomposed coolant are an economic disadvantage. Organic coolants also have poor heat-transfer characteristics and require fuel elements with extended surfaces and high conductivity cladding. Since a longer lived fuel must be developed, research and development work at present is primarily on aluminum-aluminum oxide claddings for uranium oxide and uranium alloy fuel materials. Research and development work also is directed toward lower organic makeup costs and improving organic fluid flow and heat transfer characteristics.

38. In the longer range, the research and development program will be directed toward utilizing plutonium recycle in organic reactors.

Plans for Use of Existing or Authorized Facilities

39. *Domestic civilian power program.*—(*a*) The 5- to 50-MWT organic-moderated reactor experiment (OMRE) at the Nation Reactor Testing Station is being modified to make it a more suitable test facility and to reduce its cost of operation. It will continue to be used as a fuel test facility, for determining coolant decomposition rates, and for conducting heat transfer and surface fouling tests.

(*b*) The 40-MWT experimental organic-cooled reactor (EOCR) is presently being designed with construction scheduled to start this year at NRTS. It is scheduled to be critical in 1963. This facility will have more flexibility than the OMRE. It will allow an acceleration of the rate at which alternative fuels, coolants, moderators, and operating conditions can be investigated, and it will give greater assurance that improvements will be available for organic reactors that might be built in the future.

(*c*) The 11-MWE organic cooled and moderated reactor being built for the city of Piqua, Ohio, is scheduled for criticality in 1961. It is of primary importance as a prototype for small nuclear powerplants, and it will make possible a reasonable analysis of the potential of the organic concept in this size. It will also provide operation data that can be extrapolated to larger plants.

(*d*) A 50- to 100-MWE organic-cooled prototype is planned for construction. Its primary purpose will be to provide data on use of an improved fuel such as aluminum cermet clad uranium dioxide. An invitation for proposals to build this reactor has been issued under the fiscal year 1960 authorization. Should no acceptable response be received to the invitation, and if research and development results continue to be favorable, the Commission proposes to start construction with funds included in the fiscal year 1961 appropriation request. The target date for criticality of this reactor is 1964. It is primarily a prototype for future large-scale power reactors, but the basic fuel element information which it will develop will be important for process heat and small power reactor systems.

Future Plans

40. Assuming success in operation of the 50- to 100-MWE prototype and in other research and development, it is anticipated that by 1965 or 1966 sufficient information will be available to permit utilities to decide, on economic grounds, to construct a 300-MWE organic-cooled reactor in a high-fuel-cost area.

41. In the middle 1960's continuing research and development, if successful, should indicate further improvements possible in organic-cooled reactors. A 50- to 100-MWE prototype may be justified to demonstrate these features.

III. SODIUM COOLED REACTORS

42. Sodium-cooled reactors appear to have a high potential for achieving competitive power in large areas of the United States in the late 1960's or early 1970's.

43. Sodium has many attractive features as a reactor coolant. It is liquid at relatively low temperatures, has a very high boiling point, reasonably low neutron absorption cross section, and excellent heat transfer and heat transport qualities. These characteristics make possible very high steam cycle efficiencies. Because of the negligible pressure required for sodium systems, very large-sized (500 MWE and larger) reactors are practical. This is an advantage since unit power costs generally decline with increased plant size. The experimental breeder reactor No. 1, the sodium reactor experiment, and the submarine *Seawolf* and its prototype reactor have demonstrated that sodium-cooler reactors can be operated safely. However, there still are problems with fuel elements and components which must be solved before these systems can achieve their full potential.

44. Since liquid sodium is not itself a moderator, systems which use this material as a coolant can operate over a wide neutron energy spectrum, depending upon the presence and characteristics of moderating material. In fast, and possibly in epithermal systems, sodium-cooled reactors are capable of breeding. Sodium-cooled reactor systems can also operate with uranium 238-plutonium fuel systems or with thorium-uranium 233 systems.

45. The Commission's program for sodium-cooled reactors is presented below under two headings—fast reactors and thermal reactors.

A. Sodium-cooled fast reactor

46. Most of the technical and economic advantages which are inherent in the use of sodium as a reactor coolant apply to fast systems. They have an additional advantage in their ability to achieve high conversion ratios or to breed.

47. The research and development program for fast or epithermal liquid metal-cooled reactor systems is long range in nature and is expected to yield significant results in the late 1960's. In its initial stage it will concentrate on the development of a satisfactory, long life, high burnup fuel material; on the utilization of plutonium and uranium 233 as fuels and of uranium and thorium as blanket materials; on the development of reliable and less expensive sodium components; and on the development of efficient and rapid fuel recycle methods.

Plans for Use of Existing or Authorized Facilities

48. *Domestic civilian power program.*—(*a*) Operation of the first experimental breeder reactor (EBR–1) at NRTS will be continued. Upon completion of the current safety experiments, a plutonium cermet core will be installed.

(*b*) The second experimental breeder reactor (EBR–II) at NRTS is scheduled for criticality in late 1960. The first core for this reactor will utilize uranium-235 fuel. The subsequent core will be fueled with plutonium. This plant will incorporate on-site pyrometallurgical fuel processing.

(*c*) The 94 EMW Enrico Fermi plant at Monroe, Mich., is scheduled for criticality in 1960. Test information on the uranium 10 weight percent molybdenum fuel performance, on fuel rotation, on fuel processing, on core physics and on overall plant performance will be important to the advancement of fast reactor technology.

49. *Military contributions.*—(*a*) Various military research and development efforts will contribute significant data on fast breeder systems. The development work on the SNAP reactors (systems for nuclear auxiliary power) will result in the construction of a number of small sodium-cooled reactors which will provide information on the performance of fuel elements, moderators, and structural materials, operating at high temperatures in a fast neutron spectrum.

The aircraft program includes the construction and operation of an experimental liquid metal cooled intermediate reactor. This facility will provide useful data on high temperature fuel element performance and on the behavior of other materials in a liquid metal environment.

50. Work being undertaken abroad also will contribute information of value to our program. The United Kingdom's Dounreay reactor is an experimental facility similar to a large EBR–1 and they plan to build a large (800 MWT) fast breeder plant in the near future. The French are planning a 10 MWT advanced fast reactor using plutonium as fuel.

Future Plans

51. A 100 MWE prototype sodium-cooled fast or epithermal reactor will be constructed if the results from existing or planned reactors provide a basis for improved deign. Two years of operating experience on these plants should be available before starting the new prototype. Detailed design and construction could start in 1963 or 1964. The primary purpose of this reactor will be to incorporate the improvements in design arising out of the operation of prior plants, and to demonstrate a plutonium-fueled core optimized for lowest power costs

52. With the successful completion and operation of the above prototype and with data from other plants, it is believed that, by the late 1960's, enough information will be available to permit utilities to decide, on economic grounds, to construct large sodium-cooled fast breeder plants in many areas.

B. Sodium-cooled thermal reactors

53. Sodium-cooled thermal reactors have the potential of achieving economic power in high fuel cost areas of the United States. These reactors can be operated at high temperatures and low pressures. However, to obtain full benefit from these characteristics, a greatly improved fuel element must be developed: one capable of long life in the high temperature environment. For this reason it is unlikely that this potential can be achieved at an early date.

54. Since sodium-cooled fast reactors offer most of the advantages of the sodium-cooled thermal systems and, in addition, offer the possibility of lower fuel costs through breeding, work on sodium-cooled thermal reactors would not be expanded until operating results from the Hallam reactor, now under construction, can be evaluated. Research and development for sodium-cooled thermal systems will concentrate on uranium carbide fuel development and on major improvements in the design, efficiency, and performance of the sodium components. In carrying out this program, full consideration will be given to the points of similarity between thermal and fast cooled systems and the work will be directed in such a way as to achieve maximum benefit to both.

Plans for the use of existing or authorized facilities

55. *Domestic civilian power program.*—(*a*) The sodium reactor experiment (SRE) in California will be returned to operation. For the next several years, its use will be limited to testing of advanced fuels and other work in support of the Hallam plant. When this work is completed, and if the potential of the concept shows continued promise, the SRE will be reassesed as to its suitability for conversion to a high temperature fuel test facility, or to an advanced experimental reactor to demonstrate improvements in thermal sodium-cooled systems.

(*b*) The Hallam (Nebr.) nuclear power facility is scheduled to reach criticality early in 1962. Operational plans for this 75 MWE plant include continued testing and evaluation of promising fuels, looking toward reduction in fuel cycle costs. Operating experience and tests with the plant are expected to yield valuable technical information regarding all sodium-cooled reactor plants, including those to operate with neutrons in the fast and intermediate energy spectrums.

Future Plans

56. If evaluation of the operation and tests of the Hallam reactor show a favorable potential for this concept, consideration will be given to the construction of experimental or prototype plants to exploit potential improvements. Such additional facilities will not be considered, however, until operating experience is available and therefore would not be initiated before 1963 or 1964.

IV. ENRICHED GAS-COOLED REACTOR PROGRAM

57. Enriched gas-cooled reactors have the potential of producing superheated steam of the quality currently in use in large conventional central station powerplants with the resulting high efficiency. Gas-cooled reactors can operate at low pressure and therefore can be built in very large sizes.

58. The Commission has two approaches to the gas-cooled reactors program, exemplified by the 22.3 MWE experimetnal gas-cooled reactor (EGCR) now under construction and the Philadelphia Electric Co.'s 40 MWE (28.5 MWE with metal-clad fuel) high temperature gas-cooled reactor (HTGR). The HTGR will employ a core utiliz.ng a graphite-clad fuel consisting of fully enriched uranium carbide and thorium carbide dispersed in graphite. The EGCR is a reactor utilizing stainless steel clad, slightly enriched UO_2 fuel. In the case of both reactors, heat is removed from the fuel by the helium coolant and is transmitted to a heat exchanger where steam is formed to drive the turbine. The graphite-clad system shows greater economic potential than the metal-clad system, but presents more difficult development problems.

59. The present and immediately foreseeable research and development program is concerned primarily with the design and construction of the EGCR and HTGR. Their construction and operation will make possible a more comprehensive evaluation of the potential of the gas-cooled reactor system. The program also will include investigations of fuel and claddig materials suitable for high burnup at fuel surface temperatures of 1,700° F. and higher and of alternate coolants.

Plans for Existing and Committed Facilities

60. *Domestic civilian power program.*—(*a*) The 22.3 MWE experimental gas-cooled reactor (EGCR) at Oak Ridge is scheduled for criticality in 1962. This power producing prototype will furnish statistically significant economic data on operation of gas-cooled reactors. It will be used as a flexible test facility which will permit the testing of advanced fuels, materials, and components suitable for use in future gas-cooled power reactors. Work on this project will be carried out in close cooperation with work of the United Kingdom on its advanced gas reactor (AGR).

(*b*) The Philadelphia Electric Co.'s 40 MWE (initially 28.5 MWE) high temperature gas-cooled reactor (HTGR) is being designed and is scheduled for initial criticality in 1962. The work supporting this project includes development of impervious graphite, uranium carbide-thorium carbide fuel dispersed in graphite, high temperature components, and auxiliary systems including methods for trapping fission products which may get into the gas coolant.

61. *Military and maritime contributions.*—(*a*) The Commission's aircraft nuclear propulsion direct cycle program is continuing to utilize the heat transfer reactor experiment No. 3 (HTRE–3) at NRTS. Present work is being concentrated on the review of HTRE–3 reactor design and its control system. Expansion of in-pile component testing is underway at the engineering test reactor (ETR). High temperature information developed by HTRE–3 will provide valuable information on fuel elements for gas reactor systems.

(*b*) The gas-cooled reactor experiment being conducted for the Army nuclear power program will continue in operation. This facility will provide important data on core performance, particularly on small water moderated stainless steel clad uranium dioxide cermet fuel cores and water moderated uranium dioxide or uranium-beryllium oxides pellet cores. The use of nitrogen as coolant will be investigated. Closed cycle gas turbine machinery will continue to be developed and tested.

(*c*) Development work on gas-cooled reactors for other special purposes, such as maritime propulsion, will continue to provide information important to the evaluation of the potential of gas-cooled reactor technology for large central station powerplants.

62. In addition much valuable information also will be obtained from our cooperative arrangements with the United Kingdom on the Dragon pro'ect. This is a high temperature gas-cooled reactor to be built in the United Kingdom as a cooperative project with the Organization for European Economic Cooperation.

Future plans

63. Based upon the successful operation of the EGCR and the HTGR, a prototype to demonstrate advanced features will be initiated. An evaluation will

determine the choice between the EGCR and the HTGR approaches. It is expected that this 100 megawatt electric prototype could be initiated in the middle 1960's.

64. It is believed that after operating experience is gained from the programed reactors sufficient information will be available by the early 1970's to permit utilities to decide, on economic grounds, to construct in high fuel cost areas a 300 to 500 megawatt electric gas-cooled reactor using enriched fuel.

V. HEAVY WATER REACTOR PROGRAM

65. Heavy water moderated natural uranium fueled reactors have a number of unique advantages. For example, they eliminate dependence upon diffusion plants in the fuel cycle, they have high neutron economy, and they require relatively small quantities of uranium ore per unit of power produced. On the other hand, these reactors are physically large with consequent high capital costs. The reactivity lifetime of the natural uranium fuel is more limited than that of enriched uranium fuel.

66. Several prototypes of natural uranium heavy water moderated reactors are planned or are under construction in the United States. Also, the Canadians are planning construction of both a 20 megawatt electric prototype, the NPD, and a 200 megawatt electric natural uranium heavy water moderated plant, the CANDU. These plants are scheduled for criticality in 1961 and 1965, respectively. Negotiations are currently underway with the Canadians looking toward an expanded program for cooperation in the development of heavy water reactors. Close cooperation under this agreement will be mutually beneficial and, in addition, will serve to assist the Commission and U.S. industry in determining the future role of heavy water reactors in this country.

67. The U.S. research and development program will be directed toward those problems which are critical to the evaluation of heavy-water-moderated systems. To the fullest extent possible, it will use pertinent information being developed in other programs and in other countries. The critical problems are those associated with reactivity limitations on fuel lifetime (including fuel management techniques for extending these limits), minimizing loss of heavy water, and techniques for fabricating components of pressure tube or pressure tank systems. One difficult design objective is to obtain the high coolant temperature needed for high thermal efficiency while maintaining the cool moderator necessary for long fuel-reactivity lifetime. The research and development program and cooperation with other countries will be planned so that the combined results will provide a sound basis for evaluation of this class of reactors, including designs which use coolants other than heavy water (e.g., organic and gas).

Plans for existing and authorized facilities

68. *Domestic civilian power program.*—(*a*) The heavy water components test reactor (HWCTR) is scheduled for criticality in 1961 at the Savannah River plant. This reactor will be used to obtain operating information on a heavy water-moderated system under conditions similar to those that might be suitable for power production. It will provide irradiation tests on fuel elements being considered for heavy-water-moderated systems, and will provide tests of other components such as pumps, valves, and instrumentation.

(*b*) Research and development on a cooperative basis in support of the 50 megawatt electric reactor of the east central and Florida west coast nuclear groups will continue, looking toward an early evaluation, in accordance with the terms of the contract, and a determination as to whether or not the project will proceed with plant construction. If built, the reatcor is scheduled for completion in 1963.

(*c*) A heavy water moderated and cooled pressure tube reactor of 17 megawatt electric capacity is being designed and is scheduled for criticality in 1962 in accordance with a contract between the Commission and the Carolinas-Virginia Nuclear Power Associates, Inc. This reactor will provide additional data on the performance of heavy water reactors.

(*d*) The plutonium recycle test reactor (PRTR) is scheduled for criticality in 1960. This is an experimental facility to investigate the economic feasibility of plutonium recycling. However, the fact that this reactor uses heavy water as a coolant and moderator, incorporates a pressure tube design, and operates

at power reactor temperatures, makes it an important source of additional information and technology.

Future plans

69. When operating the cost data are available from the United States and Canadian heavy water reactors it is believed that there will be sufficient information to determine whether or not construction of a large heavy water reactor is economically justified in this country. We believe such an evaluation can be made by 1966 or 1967.

VI. AQUEOUS HOMOGENEOUS REACTOR PROGRAM

70. The aqueous homogeneous reactor offers many advantages for production of power since it operates with a solution fuel, incorporates continuous fission product removal, and is largely self-regulating due to its large negative temperature coefficient. It further offers the possibility of breeding when operated on a thorium-uranium 233 fuel cycle. Major technical problems are associated with the corrosive nature of the fuel, stability of the fuel solution under irradiation, the maintenance problem associated with the radioactive primary loop, and the limited operating temperatures with the attendant low steam cycle efficiencies.

71. It is still too early to determine whether the simplicity of the fuel cycle and potential breeding will be more than offset by technical complexities and temperature limitations. Because of the unique advantages and the fact that this is the main effort on fluid fuels, research and development will be continued on the technical problems on a long-range basis.

Plans for Use of Existing Facilities

72. *Domestic civilian reactor program.*—(*a*) Research and development work will concentrate on understanding and solving the fuel stability and corrosion problems in the core and on development of a suitable blanket material. Operation of the homogeneous reactor experiment nuclear (HRE–2) facility should be directed to aiding in the solution of the fuel stability, the remote maintenance and other basic system problems.

Future Plans

73. The outcome of the research and development work will furnish guidance to the Commission in determining if a third aqueous homogeneous reactor experiment should be constructed. This experiment, if indicated as advisable, should be built in 1962–63 and should demonstrate breeding, or, as a minimum, a high conversion ratio. If the experiment proves successful a prototype of about 50 megawatts electric could be initiated in the late 1960's.

VII. NEW CONCEPTS PROGRAM

74. As technology is developing rapidly in many directions, the Commission must be alert to evaluate new reactor ideas as well as new ideas for major improvements in existing reactor types. However, a decision to proceed with the development of design alternates representing major technological advances depends upon an evaluation of the benefits expected to result. Such evaluation is difficult even when considerable technical data on each exists. Early construction of inexpensive reactor experiments may be justified to help determine the technical feasibility of advanced designs which look promising. The boiling reactor experiment (BORAX), the organic moderated reactor experiment (OMRE), and the Los Alamos power reactor experiment (LAPRE) are examples of reactors built in minimum time at low cost to provide answers to specific questions as to technical feasibility.

75. The following reactor types or reactor modifications are typical of those currently being investigated. In several cases specific reseach and development is being carried out in areas critical to the evaluation:

(*a*) Fused salt: This is a fluid fuel design based upon the use of a mixed salt solution of fissionable and fertile materials which is circulated from the reactor through an external heat exchanger. Potential advantages of this system are high thermal efficiency, low pressure, and simplified fuel reprocessing.

(*b*) Fluidized bed: This design is based upon maintaining a bed of fissionable and fertile material in a fluidized state under turbulent flow conditions. Or-

ganic material or water are considered as possible fluidizers and coolants. High power density and ease of charging and discharging fuel are potential advantages of this system.

(*c*) Paste or suspended fuel: This design is similar to the fluidized bed design except that the bed is maintained in a laminar, nonturbulent condition, and is internally cooled by a separate coolant. Many of the potential advantages of the fluidized bed are retained. In addition, because of the nonturbulence, particle attrition is reduced and reactor control may prove to be easier.

(*d*) Supercritical water cooled: A reactor based upon this concept would operate at extremely high pressure, avoiding the phase change aessociated with boiling yet permitting the generation of superheated steam external to the reactor. High thermal cycle efficiency is the potential advantage of this alternate.

(*e*) Slurry: This design is based on a fluid fuel system in which the particle size of the fissionable or fertile material is so small that it forms a suspension under operating conditions. The reactor may be cooled externally or internally. The carrier fluids undergoing most active investigation are water and liquid metals. The potential advantages of this concept are similar to those cited for other fluid fuel reactors.

(*f*) Advanced epithermal: A compromise design between sodium-cooled fast reactors and sodium-cooled thermal reactors may have advantages over either—particularly for the thorium fuel cycle. This design would include some moderation by graphite or beryllium, optimized for high conversion ratio with uranium 233 fuel consistent with economic promise. High thermal efficiency and low pressure characteristics of sodium-cooled system would be retained.

(*g*) Pebble bed gas cooled: In this concept a stationary bed of balls (or pebbles) containing the fissionable, fertile, and moderator materials is cooled by a gas. Potential advantages are in the area of low fuel cycle costs, and high thermal efficiency.

(*h*) Solid moderated, steam-cooled reactors: In this concept, heat from the fuel is radiated to the moderator (graphite beryllium oxide, zirconium hydride, etc.) which in turn is cooled by water or steam. High thermal efficiency is the principal potential advantage.

(*i*) Alternate coolant fast reactors: This design is similar to the sodium-cooled fast reactor except that alternate coolants are being considered. These include mercury, lead, lithium, sulfur, and other materials. It is believed that with certain of the alternate coolants increased efficiency and reduced costs may be attainable.

Plans With Respect to Existing or Authorized Facilities

76. *Domestic civilian power program.*—(*a*) The Los Alamos molten plutonium reactor experiment (LAMPRE) is under construction. It will be operated to demonstrate the technical feasibility of a fast reactor using a fluid or molten fuel.

(*b*) The high temperature gas-cooled reactor experiment (TURRET) under construction at Los Alamos, would establish the feasibility of operation with a gas coolant at temperatures above 2,000° F. An attempt will be made to handle a very radioactive primary system. This reactor might have direct application in supplying process heat to the chemical and metallurgical industries.

Future Plans

77. Enginering studies, research and development, and evaluation of the new reactor concepts will be continued to the point where a decision can be reached either to build a reactor experiment or to terminate the work. During the next few years it is probable that three to five of these concepts will have reached a point where construction of a reactor experiment will be justified. Subsequent evaluation of the results from these experiments may justify the construction of several prototypes.

VIII. NUCLEAR TECHNOLOGY

78. In addition to the specific work carried on under individual power reactor projects, there is an area of more broadly based development in nuclear technology. The general objectives of this program are to provide basic data on reactor systems and related problems, to carry out engineering development of a general and fundamental nature, to investigate the feasibility and potential of new methods for improving reactors, and to provide tools, such as test and

research reactors and remote handling devices, for use in reactor research and development.

79. Developments in this area should help to lower the cost of nuclear power generation through improvements affecting many types of reactors and through reductions in the overall cost of the reactor fuel cycle.

A. Fuels and materials

80. Research in this category is directed toward evaluating the potential of materials for reactor applications, determining their basic properties and developing engineering design information on nuclear fuels and reactor materials. This work will result in more efficient utilization of nuclear fuels and reactor materials in reactor cores.

81. In this field, the fuel cycle development program was established to concentrate research effort on reduction of nuclear power costs through improvements in fuel performance and reductions in fuel costs. During fiscal year 1959, 24 research and development proposals submitted by industrial organizations in response to public invitation were accepted. Additional work was assigned to National Laboratories and the research effort of other contractors was increased. Research necessary to reduce the overall fuel cycle cost includes an intensive effort to increase reactor core life and fuel burnup, increase the irradiation stability of nuclear fuel, reduce fuel fabrication costs, and attain higher temperature operation of fuel assemblies. Specific plans under these programs are as follows:

(*a*) The development of basic engineering information concerning alloys of fissionable elements, uranium oxide, uranium carbide, and plutonium—and thorium—bearing ceramic fuels will be actively pursued. In particular, additional data are required on the properties of materials at the maximum temperatures contemplated for their use.

(*b*) The effect of radiation upon the properties and performance of reactor materials will be determined with particular attention to the effects of long-term irradiation.

(*c*) To facilitate reductions in fuel cycle costs, the search for improved fabrication methods and simplified fuel element concepts to reduce fuel element fabrication costs will be emphasized.

(*d*) Research directed toward understanding the mechanisms of release or retention of fission gases will be increased in the hope of extending the useful reactor life of nuclear fuels and achieving higher fuel temperatures.

(*e*) Knowledge will be sought on the behavior of oxide fuel elements under irradiation at temperatures that result in central melting, or vapor phase movement of the fuel, in order to establish the feasibility of reactor operations under these conditions.

(*f*) Research on nondestructive testing techniques and on the development of improved nondestructive testing equipment will be continued.

B. Fuel reprocessing

82. This effort places principal emphasis on reducing the cost of reprocessing current reactor fuels and on developing techniques for processing advanced fuels in proportion to their potential. These objectives include the development and demonstration of methods for power reactor fuel reprocessing which will make possible the eventual entry of private industry into this area. At this time, proven technologies do not exist for many fuels. The demonstration program now planned will define these technologies more clearly while exploring promising alternates.

83. The program in the closed fuel cycle concept, consisting of low decontamination processing and remote refabrication, presently emphasizes pyrometallurgical techniques. It is being carried out partly as backup to the EBR–II concept, and partly in exploration of the degree to which this radical new approach to the entire fuel cycle will find application in other power reactor systems. The increasing importance of high burnup lessens the significance of fission product poisoning; at the same time direct handling of recycled fissionable materials becomes more difficult due to gamma—and beta active isotopic contamination. If economics can be favorably demonstrated, the closed cycle approach will be more compatible with these developments than the conventional direct fabrication cycle, and in addition will offer the possibility of reducing external fuel inventory charges.

C. Environmental investigations and waste disposal

84. The principal objective of this program is the engineering development of practical systems for the safe handling and disposal of the wide variety of radioactive wastes evolved from nuclear energy activities. To meet this objective requires the accumulation of quantitative information obtained from a broad program of both laboratory and field investigations ranging from evaluation of the behavior and fate of radioactive materials that may be dispersed in specific environments (air, ground, and water), to development of techniques and systems for concentrating and fixing large quantities of radioactive materials in solid form suitable for ultimate, long-term disposal in specially selected locations.

Accordingly the projects in this program include specific river, atmospheric, marine, and hydrogeologic studies on a wide geographic scale; laboratory and pilot scale studies of waste fixation schemes; and supporting laboratory investigations. The transition to prototype field and enginering projects will continue to be a significant feature of the program in the future. The results of this work are also essential for developing data related to the environmental aspects of the location, design, and operation of nuclear reactors and associated facilities.

D. Physics

85. The physics program will be directed toward the development of fundamental physics data on reactor materials such as cross section measurements of reactor materials, physics experiments aimed at improved core design and better reactivity control, and other fundamental studies to improve reactor design. This work will include research on the isotopic composition of high burnup fuel and on the effect on reactivity lifetime of fissionable isotopes and fission-produced poisons generated during long-term exposure.

E. Reactor components, and associated equipment

86. The reactor components program is directed toward the solution of fundamental engineering problems applicable to all reactor concepts and toward the development of components generally useful in power reactors. It consists of the following:

(*a*) Increased emphasis will be placed on development of means for obtaining higher heat transfer rates in reactor coolants, so that full advantage may be taken of the improved heat flux and temperatures available from high-power density cores.

(*b*) A major effort will be initiated to develop instruments, both incore, and out-of-core, to measure reactor performance, with special emphasis on measuring fuel burnup and detecting fuel failures, as well as on improved methods of measuring coolant flow rate, temperature, pressure, and steam void fraction.

(*c*) Fuel handling equipment will be developed which will make possible the interchange and remote removal and replacement of reactor fuel element assemblies without necessitating reactor shutdown. Work will also be continued on equipment for remote fabrication of fuel elements incorporating highly radioactive recycled nuclear fuels.

(*d*) Basic development of mechanical components will be undertaken to provide pumps, compressors, valves, seals, and other items for use in high temperature gas reactor systems. Work will be continued on development of improved pressure vessel and heat exchanger design and fabricating techniques to reduce the cost and increase the reliability of this equipment, and to determine the effects of neutron radiation on these structures. Techniques will be developed for remotely inspecting and testing pressure equipment after long periods of service in radiation environments.

F. Reactor safety

87. Problems in reactor safety will intensify by virtue of the increasing number of new reactors and the growing diversity of types. The reactor safety program will continue the experimental and analytical work required to provide a sound technical basis for safe and economical reactor design. The principal categories of work will deal with reactor kinetics and transient tests, hazardous chemical reactions including fission product release, and reactor containment. A major objective of the work is to develop information which may be used not only for developing sound theoretical models for predicting reactor

behavior but which also may be useful in establishing criteria and standards for the safe design and operation of reactors.

(*a*) The reactor kinetics program will continue with the operation of the SPERT (special power excursion reactor test) series of reactors and the KEWB (kinetic experiments on water boilers) reactor. The SPERT reactors are designed to obtain transient test data for the full range of heterogeneous water reactors including swimming pool, boiling water, heavy water, and pressurized water reactors. An additional feature of the SPERT II reactor is the ease with which it can be modified to conduct transient testing of organic systems. Major effort under the SPERT program will be made to obtain data and mathematical models which will be useful not only in design and for hazards analysis of reactors, but also in establishing standard test procedures for proving the dynamic characteristics of new reactors before they are licensed for operation.

(*b*) The KEWB program should be completed in calendar year 1961 with the test of a cylindrical core. KEWB data will have wide application not only to an understanding of homogeneous reactor kinetics, but also to safety analysis of chemical processing plants.

(*c*) Additional support work will be provided to the reactor transient testing program in the field of kinetics analysis, transient heat transfer, and bubble dynamics.

(*d*) The effort to determine the true hazard of metal-water reactions will try to correlate laboratory tests and theory with capsule type inpile experiments and finally, full-scale core meltdown measurements. Fission product release studies will be made inpile for the first time and generalized theories developed to allow accurate prediction of both fission product release and metal-water reaction in any credible accident.

(*e*) The high cost of containment design will be attacked by investigations of alternate methods of protection such as confinement in ordinary buildings, and the use of energy sinkes and vapor suppression schemes. In addition, data and theories of the response of containment structures to dynamic loading will continue to be investigated in order to eliminate any excessively conservative design criteria and their concomitant excessive costs.

IX. COSTS

88. The Commission has attempted, for planning purposes only, to forecast the level of costs for research and development, design and construction of experiments and prototypes, operation costs, waivers of fuel charges, and general engineering support of the civilian power program. The years immediately ahead are more easily estimated, of course, than the years later in the effort to achieve economic power. Gross total costs, including prototype but not commercial size plants, are forecast to average between $180 and $200 million a year. The bulk of the expenditures probably will be made by the Government, but industry is expected to make a substantial contribution.

APPENDIX III

CORRESPONDENCE RELATIVE TO THE STANFORD LINEAR ACCELERATOR

JOINT COMMITTEE ON ATOMIC ENERGY,
CONGRESS OF THE UNITED STATES,
April 12, 1960.

Gen. A. R. LUEDECKE,
General Manager, U.S. Atomic Energy Commission,
Washington, D.C.

DEAR GENERAL LUEDECKE: It would be appreciated if you would confirm AEC's views as to the effect of the Joint Committee's authorization of $3 million for further engineering and design work on the Stanford linear accelerator. We would particularly like your comments on whether the amount of $3 million for design and engineering is adequate, along with continued development work financed from operating funds, for AEC and Stanford to make progress on the project and to have definitive plans and detailed cost estimates for the project available for the Congress in January 1961. In this connection it is understood that the staff of the Joint Committee and the AEC staff are preparing mutually acceptable language for the report.

This will also confirm that the Joint Committee desires that an overall report be prepared on the high-energy physics program, and submitted to the committee in January 1961. Among other things, this study should include original estimates of costs of the six large accelerators already authorized (both construction and operating costs), present estimates, and a projection of total construction and operating costs associated with these accelerators over the next 5, and the next 10, years. The report should also cover the desirability and estimated costs of other large-scale accelerator projects such as the MURA project. Consideration should also be given to the possibility of joint projects of an international nature with other countries interested in participating in accelerator work.

Sincerely yours,

CLINTON P. ANDERSON, *Chairman.*

U.S. ATOMIC ENERGY COMMISSION,
Washington, D.C., April 14, 1960.

Hon. CLINTON P. ANDERSON,
Chairman, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR SENATOR ANDERSON: As we stated in our letter of April 13, 1960, to Mr. Van Zandt, at the present time work on the Stanford accelerator program has reached the stage where the next logical step would be to proceed with the design of the overall site plan and the design and construction of general laboratory facilities to house the design and engineering group and to conduct the research and development programs.

It is the Commission's view, however, that an authorization of $3 million for design and engineering in fiscal year 1961 on the Stanford linear accelerator would allow the Commission to proceed with a program that would lead to initiation of construction with a minimum of delay following full authorization of the project. It is the Commission's view that the amount of $3 million for design and engineering together with operating funds for continued development work is adequate for Atomic Energy Commission and Stanford to make progress on the project. While the Commission believes that the current estimate of the construction and operating costs of the accelerator are reasonably dependable we should be able to have more definitive plans and detail cost estimates for the initial phase of the project available for the Congress in 1961. Our views are based on an understanding that the staff of the Joint Committee and the Atomic Energy Commission staff have agreed on language for the report which will permit the complete design of buildings, site layout, specifications and drawings for the accelerator housing and such other action that would lead to the initiation of construction at the site with a minimum of delay after full authorization of the project.

The Commission will prepare the requested overall report on the high energy physics program and submit it to the Joint Committee in January 1961.

Sincerely yours,

JOHN F. FLOBERG, *Acting Chairman.*

On April 11, 1960, Congressman Van Zandt requested the AEC to state its position, and received the following letter dated April 13, 1960, from Acting AEC Chairman John F. Floberg:

U.S. ATOMIC ENERGY COMMISSION,
April 13, 1960.

Hon. JAMES E. VAN ZANDT,
House of Representatives.

DEAR MR. VAN ZANDT: In response to your inquiry, our position as stated before the Joint Committee on Atomic Energy during the recent authorization hearings is that the Stanford linear accelerator project should be fully authorized for construction at this session of Congress.

The Commission has given careful consideration to the recommendations of the scientific community as expressed through the science adviser to the President. We have concluded that undertaking the construction of the Stanford accelerator is logically the next step in a balanced high-energy physics program. The construction and operation of this machine would put in the hands of the U.S. physicists a most necessary tool if we are to achieve maximum scientific

progress. The Commission believes that the current estimates of the construction and operating costs of the accelerator are reasonably dependable.

At the present time work on the Stanford accelerator program has reached the stage where the next logical step would be to proceed with the design of the overall site plan and the design and construction of general laboratory facilities to house the design and engineering group and to conduct the research and development program.

On the assumption the committee would approve only $3 million for design and engineering in fiscal year 1961, we feel the Commission could proceed at this time, under the broad authorization language discussed with the AEC, with a program that would lead to initiation of construction with a minimum of delay following full authorization of the project. This type of authorization would provide for complete design of buildings, site layouts, specifications, and drawings for the accelerator housing, and such other detailed design and engineering of the master plans for the project, and the securing of bids.

We believe that the lack of full authorization of the project at this time may seriously hamper the recruitment of the additional top staff necessary for orderly progress of this project.

Sincerely yours,

JOHN F. FLOBERG, *Acting Chairman.*

APPENDIX IV

The following tentative figures on construction and operating costs of high energy accelerators were obtained informally from AEC staff. AEC indicated that these figures require updating and will be included in the report due January 1, 1961.

[In millions]

Machines	Estimates			Remarks
	Initial	Current [1]	Future [2]	
Cosmotron (BNL):				
Construction:				
Basic machine	$4.0	$9.3	----------	
Additions and modifications.	----------	3.9	$1.5	The estimate of $1,500,000 represents an annual requirement of $300,000 for machine changes.
Operating costs [3]	1.7	4.1	4.6	The estimate of $1,700,000 represents the 1st full year of operation on a 1-shift basis.
Bevatron (LRL):				
Construction:				
Basic machine	9.0	9.7	----------	
Additions and modifications.	----------	4.2	11.6	The amount of $11,600,000 represents major improvements to the bevatron, including additional shielding, a new injection system, and external beam facilities.
Operating costs [3]	2.2	11.7	25.5	The estimate of $2,200,000 represents the 1st full year of operation on a 1-shift basis. The estimate of $25,500,000 represents an expanded research program with the vastly improved bevatron and round-the-clock operation.
AGS (BNL):				
Construction:				
Basic machine	20.0	31.0	----------	
Additions and modifications.	----------	1.5	7.4	The amount of $7,400,000 represents an annual requirement of $1,200,000 for machine improvements plus housing for the bubble chamber ($1,600,000).
Operating costs [3]	1.7	[4] 8.9	9.6	The amount of $1,700,000 represents a 1953 estimate and does not include laboratory overhead.

See footnotes at end of table, p. 492.

[In millions]

Machines	Estimates			Remarks
	Initial	Current [1]	Future [2]	
ZGS (Argonne):				
Construction:				
Basic Machine	$27.0	$29.0	$13.0	The original authorization contemplated a Midwest high energy accelerator costing $15,000,000. No work was ever done on this project but the authorization was amended to provide for the construction of a 12.5 Bev accelerator to be located at Argonne. The initial estimate for such a machine was $27,000,000 and the earlier authorization was amended accordingly. The current estimate for the ZGS machine authorized at $27,000,000 is $29,000,000. However, it is apparent that certain additions, including 2 external beam experimental areas, should be made now to obtain maximum utilization of the machine, and amended authorization for $42,000,000 should be sought. The amount of $17,000,000 shown for future additions is comprised of $10,000,000 for 2 more external beam experimental areas (fiscal year 1965), and $7,000,000 (fiscal year 1962) for housing and laboratory space required by the high energy physics group that will be using the accelerator for research.
Additions and modifications.	----------	----------	17.0	
Operating costs [3]	6.1	[4] 9.4	15.6	Eventual operation of the ZGS with four external experimental areas is estimated at $20,000,000 annually.
Cambridge electron accelerator:				
Construction:				
Basic machine	6.5	10.2	----------	The initial planning for 2 university accelerators envisaged a total cost of $20,000,000 for the 2 machines. The estimates for the 2 proposals that were accepted (Cambridge and Penn-Princeton) totaled $42,300,000. The current estimate for these 2 machines totals $21,400,000 and does not include the Penn-Princeton contribution of $5,000,000. The amount of $1,500,000 shown for future additions to the Cambridge machine contemplates an annual requirement of $300,000 for machine changes.
Additions and modifications.	----------	1.4	1.5	
Operating costs [3]	1.0	[5] 6.6	8.1	
Penn-Princeton accelerator:				
Construction:				
Basic machine	5.8	11.2	----------	The amount of $13,300,000 for future additions to the Penn-Princeton machine includes $9,400,000 for external beam facilities, $1,400,000 for an additional wing to the laboratory building and $2,500,000 representing an annual requirement of $500,000 for machine changes.
Additions and modifications.	----------	----------	13.3	
Operating costs [3]	1.0	[6] 4.2	5.0	

[1] The estimates in this column are applicable to fiscal year 1960, except where noted otherwise.
[2] The construction estimates in this column indicate future additions required through fiscal year 1965. The operating estimates indicate the annual level required in fiscal year 1965.
[3] All operating figures represent annual estimates required for operation, research, and equipment associated with each machine.
[4] 1961.
[5] 1963.
[6] 1962.

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